

2 Regional Workshops Raw Data

The information contained in the follow tables is the unprocessed data recorded during each of the workshop sessions and provided as a handout to the attendees at the conclusion of each workshop.

Caribbean Workshop

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Ocean Dynamics and Interactions & Mapping					
Information Need/Gap	What	Why	Where	Technologies	Votes
Understanding of relationship between hydrates and cold seeps/vents and sediment flows and biota (including microbes) and brine pools	discover new species and processes; understand relationships	potential new bioengineering products; serve as areas of production "oases"; ocean resource management (ex. protection of the communities)	hydrate stability zone; 300m - <3km; northern Gulf; Campeche Banks and Bay; commercial tracts	ROV; AUV; sub; sampling; video; moored application	13
Location and understand gas hydrates	determination of location and volume of hydrate resources; classification; chemistry	energy source; impact on environment (climate, carbon cycle); geohazard/sea floor stability	300m-3km (maybe more) depths; emphasize below 1000m (E. Texas to W. Florida); EEZ; outcroppings; arctic	acoustic mapping; ROVs; sampling systems; video; sub; AUVs; sensors for gas analysis	12
Understand deep water impacts from significant weather systems (ex. Hurricanes)	characterize ocean under severe weather and ocean bottom in real-time	learn of impact on habitats, ecosystems, geomorphology; has not been observed before; benthic recovery; determine if relationship between tracks and water	tropical storm tracks in Gulf	AUV; fixed sensors including hydrophones; sensor arrays	11
Characterize deep MPAs (including deep reefs)	baseline knowledge of existing conditions	ensure knowledge of the constituents that need protection; PSBL Biotech applications	existing MPAs (3 W. FL shelf); Flower Garden Banks	sub/ROV; deep diving capabilities; manned observatory (human habitat); fixed sensors; AUV; good video	10
Interaction between loop current and related circulation features & fisheries	impact on ecosystems and habitats	lack of knowledge related to fish populations; correlation with boundary/events	Yucatan Channel; shelf break along northern & eastern Gulf	fixed & vessel-based ADCPs; tomography; "tailored" AUV; ROVs, cameras, and sampling tools; sensors for ID nutrients; drifters; profilant floats	9
Understanding of Gulf currents on offshore structure	impact on engineering and DESIGN; partnership with platforms	ability to predict loop currents; safety and SS; contaminant control; national security; better understanding	northern Gulf; energy exploration areas	instrumented platform; deployed and fixed current meters; drifters; profilant floats	6
Identify areas that are candidate MPAs	baseline knowledge of existing conditions; ID biota that needs protection; habitat characterization	conservation; impact on surrounding habitat; management and policy	Green Canyon; Mississippi Canyon; Dasoto Canyon; PSBL Yucatan Channel	sub/ROV; deep diving capabilities; manned observatory (human habitat); fixed sensors; AUV; good video; acoustic mapping (single/multibeam)	6
Interaction between loop current, related circulation, and hydrate stability	relationship between ocean properties and hydrates/beds	geohazards understanding (safety)	loop current and depth <3km; commercial lease tracts	fixed & vessel-based ADCPs; tomography; "tailored" AUV; ROVs, cameras, and sampling tools; sensors for ID nutrients; drifters; profilant floats	5
Understanding of distribution and process details of fluid and gas expulsions, carbonate formations, and seismic activity	knowledge of bottom boundary dynamics	tipper for hydrocarbons (energy resources); fish habitat; geohazards; climate/carbon cycle	slope waters <3km; E. Texas to W FL slope	seismometers; ROVs/subs; video; sampling	5
Location and processes near sites of potential threat to the environment	wrecks; marine debris; dump sites; abandoned platforms	pollution impact; long-term anthro. impacts; safety; ecosystem health	suspected debris sites; dump zones; wrecks	acoustic mapping; single/multibeam; sub/ROVs; AWOIS; video; samples	5
Knowledge of sub-bottom characteristics	morphology; composition; dynamics	characterize acoustic backscatter; identifier of hydrate deposits and industry zones	slope waters <3km	acoustic sounders (high resolution, seismic); vertical arrays; AUVs	4
Understanding distribution and migration pattern of marine mammals	response to anthropogenic impacts (noise, other pollution)	conservation; public interest	migration routes; commercial lease tracts (1km contour and loop current events)	acoustic tags; fixed hydrophones; sensor arrays	3
Understanding of loop current related currents relationship to HAB formation and other species that are not normally seen	discover mechanisms of transport that leads to formation and distribution	human health issue; economics; recreation industry; impact industry (shrimp, oyster, and fishing)	west FL shelf; Yucatan Straits (source); E. Texas; northern Gulf	remote sensing; towed arrays; ROV/AUVs; sampling; drifters (SVP); HDTV	2
Characterize canyon processes	sediment fluxes; turbidity flow; erosion; chemistry; upwelling	understanding distribution of sediments; knowledge of depositional cycles; impacts on marine mammals and pelagic communities; nutrient production	Mississippi Canyon; Desoto Canyon; Green Canyon	ROVs/AUVs/subs; video; sampling	2
Location and dynamics of archaeological sites of historical significance	wrecks; submerged structures	preservation; creation of habitat; interests the public; maritime heritage	candidate sites resulting from prior surveys	acoustic mapping; single/multibeam; sub/ROVs; AWOIS; video; samples	2
Understand impacts of Mississippi River outflow on habitats, ecosystems (and secondary fresh water input)	Determine river influence on Gulf systems; bio/geo/chem; frontal zones	Regulatory oversight of runoff quality; remediation; impact on fisheries; bottom health; flux of nutrients	Flower Garden Banks to FL Keys	sensor arrays; fixed sensors; AUVs; remote sensing; ROVs	1
Location of new mineral resource deposits	shell; sand	possible economic viability; shoreline protection	EEZ	core samples; ROVs/AUVs	1
Ability to generate energy from ocean renewable resources (currents, vents)	detailed baseline knowledge of candidate currents/locations	possible new energy resources	candidate bathymetry near loop and related currents, vent locations	instrumented platform; deployed and fixed current meters; drifters; profilant floats	

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs
Emphasis Area: Ocean Dynamics and Interactions & Mapping
(standard package = class 1 or 2 vessel; ROV/sub/AUV with video & sampling and high speed communications; acoustic mapping capability; precise positioning system)

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Information Need - Approaches	Description	Key Benefits	Feasibility	Enabling Technologies	Partners / Available Assets
Understanding of relationship between hydrates and cold seeps/vents and sediment flows and biota (including microbes) and brine pools;					
Location and understand gas hydrates; Fluid gas expulsions					
1 - vessel (standard package) + high resolution seismic		biotech products; industry gains (includes safety); ocean management; science; education; homeland security; fishing industry	mod (\$\$)	3km capable ROV; synthetic aperture sonar; laser line scanner; pressurized hydrate cores; optical spectrometers; mass spectrometers; HDTV; heat flow sensors; resistivity sensors; reusable biosensors	USN; Mexico; Areté; Univ of Miss; USM; Universities; NURC; LUMCOM; NDBC; Canada;
2 - fixed sensors			mod (\$ for comms)	vertical arrays; resistivity sensors; sea-floor probes; geophones; time lapse imaging; AUV "garage"	
3 - existing data mining	data bases		mod-low (accessibility)	data recovery technologies	NAVO; NRL; energy companies
4 - remote sensing	surface expression		mod	SAR	
Interaction between loop current, related circulation, fisheries, habitats, offshore structures, HAB formation, and hydrate stability	physical water impacts				
1 - remote sensing	satellite, aircraft	fisheries management (incl shrimp & oysters); better weather forecasting;	mod	hyperspectral sensors	NWS; Universities; NURC; USN; energy industries
2 - vessel (standard package)	expedition to locations/events	safety; economy; public interest;	high	ROVs/AUVs (mobility); HDTV	
3 - fixed sensors & arrays		containment control (structures);	high	ADCPs & CTDs & hydrophones; vertical array sensors; data link	
4 - data mining	existing data bases	national security; human health;	mod		
5 - drifting sensors		science; education; understand & predict geohazard events	high	data link; ADCPs & CTDs & hydrophones; vertical array sensors; data link	
Characterize "deep" MPAs (including deep reefs);					
ID candidate MPAs;					
Location & dynamics of archaeological sites of historical significance					
1 - vessel (standard package)	expedition	biotech products; conservation; management;	high	diving technologies; HDTV; synthetic aperture sonar; laser line scanner	energy companies; NURC; NMFS; Universities; USN
2 - data mining	data bases	education; science;	mod	data mining technologies	NIH; state gov'ts
3 - manned observatory		public affinity; info for enforcement	low (\$ & risk)	deep water capability	commercial fisheries; sport fishing
4 - fixed sensors and arrays			high (\$ for comms)	time lapse imagery; data link	
Understanding impact of significant weather (hurricanes) on deep ocean					
1 - AUV	not deployed from surface vessel		mod	video; acoustic mapping; hydrophones; chem/bio sensors; AUV range capability; AUV stationed underwater - "wake up"	NWS (HRD); USN; NMS; NMFS; energy companies; insurance industry

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2 - fixed sensors	data buoys; bottom sensors	risk assessment safety; ability to assess impact on habitats and ecosystems; education; science	high (with current technologies)	time lapse imagery; video; sector scan sonar; hydrophones; ADCP; chemical sensors; acoustic biomass; phosphorescence sensors; genomic probe; optical spectrometer; nutrient sensors; data link	
3 - drifting sensors			mod	vertical array (ADCP; CTD)	
Location and processes near sites of potential threat to environment					
1 - vessel (standard package)	(esp. acoustic mapping)	conservation; management; safety; lots of public interest; remediation	high	sampling (bio/chem/physical); coring; video; acoustic mapper; radiological sensor; networked AUVs	EPA; NMS; state gov'ts; NOS (HAZMAT); media?
2 - data mining	data bases	policy; regulation; enforcement;	mod	AWOIS	
3 - fixed sensors and arrays	(when location is known)		high	time lapse imagery; video; sector scan sonar; hydrophones; ADCP; chemical sensors; acoustic biomass; phosphorescence sensors; genomic probe; optical spectrometer; nutrient sensors; data link	
Impact of Mississippi River outflow and other secondary fresh water sources on habitats, ecosystems					
1 - remote sensing	space-based; aircraft	coastal zone management;	mod	hyperspectral; ocean color	NMFS; NASA; USN, NOS, Universities;
2 - drifters		fisheries management;	high		commercial fishing;
003 - vessel (standard package)		conservation; public interest; policy remediation;	high	physical sampling; hyperspectral; video/HDTV; towed geo/chem/bio sensors; mass spectrometers	sport fishing; EPA; states; NMS; USACE
4 - fixed sensors and arrays		science; education	high	geo/chem/bio sensors; nutrient sensors	

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Observation and Mapping					
Information Need/Gap	What	Why	Where	Technologies	Votes
2. Mapping of the Gulf	bathymetry	not done in many areas; slope is an important habitat, resource management, use bathymetry to find habitat fish association - seasonality	slopes, shelf regions, western Gulf off Texas coast - East Breaks area, Eastern Gulf, all of Western Florida, 4 reserves closed to fishing - 2 in Tortugas and 2 in West Florida, Northwest Gulf; partner with Mexico to map Yucatan	multibeam, subs for groundtruthing, utilize backscatter data	15
16. Mapping between known topographic features (goes with #1)	mapping, inventory and characterization	unknown regions	all over shelf	mapping technologies, sampling, ROV's, subs, sidescan, towed systems	2
17. Chemosynthetic communities (subsurface - down several km): oil seeps and vent communities	inventory and characterize, isolated ridge system, new biota, larger geographic context	unknown regions, new biota, explore why communities exist, what turns these areas on and off?, significant communities through evolutionary time, global importance, genetic links between regions	Cayman Trough - major area to explore - lots of unexplored oil seeps, Southern Gulf, Barbados, Trinidad, West Africa - have some taxonomic affinities to those in Gulf of Mexico	multibeam, geophysical techniques, sampling techniques, satellite imaging, towed vehicles, subs, AUV's, look at new technologies	10
20. Cayman Trough	mapping, plume prospecting, inventory and characterize	significant potential for hydrothermal activity (active spreading center) and not mapped, can do it in a short amount of time	Cayman Trough just outside Gulf	CTD's, multibeam	6
3. Fluid and gas expulsion	map 3-D seismic data, high resolution data	ID chemosynthetic communities, resource management, what are the controls on the fluid and gas expulsion?	Continental slope, deep water, shelf, Mexico, Cuba, Florida Keys, Florida Gulf	subs and ROV's	4
26. Rivers of warm, dense brine	heat flow measurements, mapping, origin, effects	explore origin and effects, Gulf is a major salt province	Sigsbee Escarpment, Orca Basin	observations, mapping technologies, CTD, acoustics	1
5. Exploring the deep benthos for biological communities	genomic mapping - non-traditional, cataloging for biotechnology	biotech application, genetic makeup, resource management	deep Gulf - start at around 200m	genetic technology, subs, box cores, trawls, trapping	8
14. Genetic connectivity of Gulf ecosystems	biodiversity, genomic mapping	resource management, marine bioconservation, recruitment patterns, larval dispersal and distribution, levels of input/ geographic contributions of recruits, Flower Gardens northern most reef system in Gulf	upstream and downstream of productive fishery areas - MPA's, Keys, Banks; major eddy systems	genetic technology, plankton tows, traditional sampling techniques, ROV's and subs, deep water collection	5
1. Distribution and status of deep water corals	diversity, health, size/class distribution, taxonomy	Discover role in enhancing local species diversity; deep water fisheries habitat, resource management	Lophilia Banks - deep coral banks in outer continental shelf-Biosca Knoll, Southern Gulf of Mexico - Sigsbee Knoll and Challenger Knoll	subs, Alvin or deep ROV	4
19. Charismatic megafauna (whales, manta rays, sea turtles, dolphins, whale sharks, etc)	location, distribution, migrations patterns, reproduction, general life history questions, genetics	not well studied, some species are endangered, use of man-made platforms, resource management, outreach/education	Gulf shelf, specific topographic features associated with them, man-made platforms	tagging, satellite, imaging, acoustic, hydroacoustic, genetic technologies	4
23. Lithohierms	map, identify and characterize, geology	Not studied, may find deep corals on them, unexpected discoveries	between Bahamas and Florida	ROV, towed vehicles, AUV's, subs, geophysical technology	3
4. Time observation of topographic areas; revisiting topographic features that have significant biological communities	change in bathymetry, time lapse data	access fish stocks, assessing changes in habitat and populations, species composition, resource management	Florida Gulf and Keys, Pinnacles off MS/Alabama, Northwest Gulf, Mexico	time lapse video to observe activity	2
6. Explore submerged historical and cultural sites - Pleistocene shoreline	Inventory and characterize what's there, record of sea level change	Assess rate of change - based on sea level change, national heritage, how humans and environment responded to sea level change, resource management	edge of Shelf, Bright Banks	sub-bottom profiler, SCUBA, ROV's, subs, sidescan, magnetometers	3
21. Monitoring natural (biological and geological) and anthropogenic noise	effects of human induced noises on biota, natural noise	natural noise can be used as a measurement of health - can be used as a proxy for measurement of animal health	MS Delta where whales are located, human built platforms, protected regions, essential habitats	acoustic technologies, new technologies	3
27. MS canyon river-like structures at bottom	origin, effects,	Not studied, origin unknown, inventory and characterize, potential for unexpected discoveries, Gulf characterized as a brine system - could be global question	MS Canyon	subs, sampling techniques	2

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18. Canyon systems	microbial communities, geochemical	effects on adjacent ecosystems, unknown microbial communities	Orca Basins, smaller brine pools elsewhere, Gulf	innovative microbial techniques, sampling techniques, chemical sensors, point sampling with ROV's and subs	0
12. Shoreline erosion - Gulf of Mexico	erosion rates, habitat loss, sedimentation, storm surge impacts	public concern, economics, protection from storm surge	Gulf of Mexico, TX, Alabama	remote sensing, aerial photo, satellite imagery, maps	2
10. Hypoxia phenomenon	origin, effects		Gulf of Mexico dead zone, look at all river mouths	collect standard oceanographic parameters	1
11. Subsidence in LA	salt water intrusion, habitat loss, impact, invasive species, impacts on infrastructure	public concern, loss of wetlands and other habitats	coastal LA - most severe there		1
7. Mid-water exploration	characterization of organisms	larval distributions, taxonomy, little known of mid-water regions, charismatic species, resource management	Gulf, off mouth of MS river - resident population of sperm whales over 1,000m line so there must be a resident population of giant squid, Straits of Yucatan and Straits of Florida - Gulf connections	mochness, imagery, sensing, new technologies	2
15. Slope stability studies	debris floats, gas, slopes, faults, gas hydrates, mud flows, inventory and characterization, data features	oil and gas exploration and production, habitat modifying phenomenon	continental slope, Mobile West, Florida escarpment, sigsbee	geotechnical, sidescan sonar, dating techniques, sampling, core samples, high resolution geophysics, multibeam, sub-bottom systems	2
9. Turbid water coral communities	presence and distribution, morphology	emerging field of study, resource management, genetic info, influence of turbid water on benthos	Northern Gulf region, MS River region	food chain analysis, light meters and other monitoring equipment, water chemistry	2
8. Zoogeography of offshore man-made structures - oil and gas structures	taxonomy, diversity, distribution	little known, introduced species concerns, effects on pelagic communities (tuna question), biotech applications, resource management	Shelf and deep water, intertidal and subtidal structures	SCUBA, ROV, imaging, standard sampling techniques - collection, modeling	2
25. Exotic invasive species	where do they come from?, how did they get here?, where are they successful or not successful?, impact, taxonomy, genetics	economics, resource management, ecological, can be added on to other projects	everywhere from coast to far offshore regions	standard sampling, genetics, taxonomy, modeling	1
22. Montserrat	hydrothermal activity	active volcano	Montserrat		1
24. Cross Gulf migratory birds	migratory birds - songbirds, contribute to database	not much known, contribute to database, can use existing platform structures, what role does Gulf play in transoceanic bird migration?, can add bird studies to any other study	Western Gulf mainly, Cuba to Florida	visual observations, radar	0
28. Mega-furrows	origin, physical characterization over time, size, shape, currents	recently identified in Gulf, impact on currents, don't know where sediment goes from erosion	found between 5-7,000 feet - base of the Sigsbee	high resolution bathymetry, geotechnical technologies	0
29. Neuston	identify and characterize	very little information, may be unique with amount of oil naturally occurring in Gulf, biotech applications, pharmacological applications	sites of persistency of oil slicks, Bush Hill - Northern Gulf	satellite, sampling	0
13. Tropical cyclogenesis	air/sea interactions	hurricanes generated in Gulf, short-term warnings	Entire Gulf	offshore meteorology, satellite data, data buoys, ocean observing systems	0
CD ROM on evolution of Gulf of Mexico and talks of Cayman Trough - Tom McGee			Regions to look in - Region around Montserrat (sp?), PR Trench, Cayman Trough, Windward Island, Barbados - mouth to mouth expedition		
Develop new technologies such as in-situ cameras with high bandwidth, antifouling technology					
There is a huge private database for Gulf - petroleum exploration - have to partner with them					
Universal application of GIS technologies					

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Emphasis Area: Observation and Mapping					
Information Need - Approaches	Description	Key Benefits	Feasibility	Enabling Technologies	Partners / Available Assets
1. Mapping of the Gulf					
a. physical mapping - funnel approach; maybe NOAA can fund another group to do this	map, select sites, dives - selectively target between topographic features, subs, AUV's, ROV's; intellectual mapping, time series data	scientific - utility of dataset once it is developed, framework for further exploration, discovery of new resources (fishery, bioproducts, chemical, oil); outreach - new discoveries, interactive website; industry - new resources, fisheries, biotech, oil; education - tapping into grad students, incorporate data sets into curricula such as GIS classes	high	standard package, backscatter data, NOAA database	oil and gas industry, MMS, NMFS, seismic companies (SELL), HARTE marine institute, other existing efforts, USGS, Naval Oceanographic service, sea map, GOMP (EPA), academia, NGO's
2. Chemosynthetic communities					
a (1). Seeps - survey approach	subsurface 3-D seismic surveys, biogeography (sample), go deep	scientific - distribution, gas chemistry (plumbing system), biodiversity, biogeography; industry - may promote restrictions, resource management, biotech; outreach - sexy topic	high	satellite images, oil data, sampling technologies, coring, access industry datasets, chemical sniffers, spectrometers, isotopic work, microbiology, molecular tools, sampling technologies	WHOI, HBOI, NSF, MMS, DOE, NASA, ONR, Universities, industry pharmacology, oil and gas, biotech, Mexico
a (2). seeps - target approach	high probability targets, need to go to the bottom (biogeog), go deep		high		
b (1). Vents - Cayman Trough - targeted funnel approach	locate plumes, then use ROV's, sidescan, AUV's, general mapping	scientific - biodiversity, biogeography, key biogeographic province for global hydrothermal geography, connectivity question, high potential for new discovery; outreach - sexy topic; industry - biotech, resource management	high	plume prospecting - do multibeam and then use sensors to look for plumes, standard package, geophysical tools, microbiologists, ecologists, molecular science	NOAA - PMEL, NSF - Ridge Project, National Geographic, SLOAN Foundation, International interest, NGO's, USGS, Universities, Mexico, EEZ states
3. Exploring the deep benthos; genetic connectivity; deep water corals					
a. soft bottom deep - targeted	deep Gulf of Mexico is most heavily studied soft bottom in world, sampling, trawls, subs, genetics, Gulf is a marginal basin - distinct zoogeographic province	scientific - placing deep Gulf into zoogeographic context; industry - bioprospecting, resource management, habitat mapping; outreach - very interesting animals, interesting ecology, sexy topic	med-high	box cores, trawls, subs, standard sampling, molecular tech, genetic, mapping, development of new technologies that are cost-effective	MMS, NSF, standard funding structure, FMRI, Sea Grant, Mexico, Cuba, Census of marine life, NIH
b. hard bottom deep - funnel approach	mapping identifies hard surfaces - can't trawl or box core, so photo, ROV's, subs, geology important; non-chemosynthetic hard bottom poorly studied, looking for topographic highs, lithohems, lophilla mounds, sink holes - topographic lows - have lots of fish and corals associated with them	scientific - characterization, distribution, high likelihood of bioprospecting success, biodiversity, molecular; outreach - new communities, sexy topic, can work this stuff into curriculums, video clips on internet; industry - bioprospecting, government NIH, resource management	high	photographic surveys, ROV's (limited with currents), subs, 3-D/4-D seismic, need better sampling technologies and photographic video gear, correlating arrays	
c. time series monitoring	post-funnel, depends on community, new species		med-high	photographic monitoring, in-situ or repeat visits, chemical monitoring, census of organisms with surveys, vertical hydrophone arrays already in Gulf - can hook up with Gulf of Mexico Research Consortium	
Problem in Gulf with meta-data management - need to collect data in useable manner					
4. Charismatic megafauna (whales, dolphins, manta rays, sea turtles, whale sharks, etc)					
a. acoustic tracking (passive - such as hydrophone arrays)	hydrophone		high	aerial surveys, hydrophone, imagery	oil and gas spotters

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Emphasis Area: Observation and Mapping					
Information Need - Approaches	Description	Key Benefits	Feasibility	Enabling Technologies	Partners / Available Assets
b. acoustic (active - such as tagging)		outreach - fascinating to public - huge outreach component - warm and fuzzy; industry - resource management; scientific - distributions, global entities and don't know much about them, how do large man-made structures affect their distribution/migration, reproduction, genetics	high	satellites, various tagging equipment and tech (pop-up, etc), smaller vessels, genetics, endocrinology, biochemistry	recreational fishing communities, big non-profits such as TNC, WWF, Ocean Conservancy, media, BBC, Discovery Channel, academic institutions, industry
b (1). Opportunistic tagging	carry tagging kits on cruises or have on hand in other situations		high		
b (2). Targeted tagging; video/filming species	target at aggregation sites		high	photo equip, ROV's, subs, in-situ cameras, motion sensor cameras, time-lapse cameras	National Geographic
5. Zoogeography of man-made offshore structures - oil and gas structures				standard package - largely diving and ROV's, GIS	
a. dive from rigs, ships with divers	diving, subs, sampling and tech diving, systematically go to rigs	scientific - characterization, distribution, invasive species, understanding the role of these structured +/-, how do they affect the life-cycle of fisheries, are they just FAD's; industry - resource management, pro's and con's of platform removal, provide other options for platforms not in use, biotech; outreach - interesting to public	high	commercial equipment to collect species from rigs, need industrial strength samplers	standard, high potential for industrial partners, Universities
b. recruitment plates attached to platforms	broad scale, formally design		high	low tech recruitment plates	
c. time-based observations	depth is a very important component, systematic approach		med-high		
d. Sargassum mat time-based observations at rigs	modeling, observe before and after mats pass rigs,		med-high		
Because of Sept 11 may have more difficult time gaining permission to approach platforms					

Gulf of Mexico Workshop

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Ocean Dynamics and Interactions & Mapping					
Information Need/Gap	What	Why	Where	Technologies	Priority
Impacts of Underwater topography (Sea mounts, pinnacles, reef edges)		Baroclinic effects, nutrient production, biological productivity, ID hot spots of biological diversity	warm water environments, banks, shelf edge		13
Knowledge of fisheries habitats	scope and variability of tropic productivity in reef systems	Insufficient scale/depth; define critical path and corridors; including eddies and bio-physical connections	20-200m	single and multi beam acoustics, airborne LIDAR, video	11
Understanding the ecology and oceanography of Florida Straits	Source H2O currents, pollutants, Nutrients, Plankton	Need multidisciplinary knowledge & Coastal Dynamics	Florida Straits, VI, Puerto Rico	drifters, probes, instrument arrays, fixed ADCPs	10
ID and characterization of deep coral reefs		shallows fisheries impact deep reefs and vice versa, can be a biotech resource; ID Relationship between depth and diversity, climate indicators	Florida Straits, South end of Cuba, VI, and Puerto Rico, Marquesas, Lots of Places - beyond >20m	rebreathers, use of ROVs, subs, mixed gas, optics, acoustic mapping, radio tagging	10
Application of new micro/macro organisms on drug discoveries & other industrial products	discover new products		deep reefs, vent, seeps		10
An assessment of biodiversity	microbes, invertebrates	basic understanding needed; potential for applications	coast to the trench		10
Microbial Interactions	Impact on Ecosystems and human & habitat health	Need fine-scale knowledge	reefs		9
Continuous and long-term Systematic Observation	Bio/Geo/Chem/Physical Properties	Need long-term trends, context	coastal area followed by everywhere else	(Fixed and Dynamic) Sensor arrays, remote sensing, omnipresent video, develop low light technology	9
Interactions between abyssal depths and shelf waters (including abiotic/biotic constituents)	unexplored, ID geothermal activity, understand dynamics of nepheloid layer		Puerto Rico Trench and surrounding area	deep submersible	7
Mechanisms underlying Fish aggregations	pelagic and benthic	understanding of dynamics of fisheries and ecosystems; conservation and management	VI, Puerto Rico, Bahamas, Florida Straits, Mexico, Belize	rebreathers, use of ROVs, subs, mixed gas, video, radio tagging	6
Dynamics of interaction between water masses		Insufficient scale and depth, ID impact on productivity	Florida Straits, VI - Anegada Passage: loop current production to Florida Straits		5
Information on Anthropogenic Noise in H2O	ships, blast fishing, Military Ops, Energy Refineries	Impact on ecosystems	Puerto Rico (super port), Bahamas, St. Croix	SOSUS, deployed arrays, ship surveys	2
Impacts of energy conversion activities	Anthropogenic impacts	understand impact on biota	Florida current, deep trenches	systematic obs	2
Additive and Synergistic Effects on ecosystems		How does it affect fisheries?		emerging sensors	1
Connection of separated populations (esp. fish)	How Habitats impact each other	larval transport pathways unknown	throughout Caribbean		
Techniques for characterization on a short time-scale (in the field)		Apply medical tech to marine environment			
sharp topography - no study in warm environment					
Impact of Fresh H2O runoff & Suspended/Dissolved "stuff"	ID and quantity	Impact on ecosystems & habitats - Info on land use activities	All Coastal Regions		
Linkage between marine mammals & food source/distribution (includes vertical migrators)		Migrating instruments			
Anthropogenic impacts on marine mammals and their habitats		ID competition for resources and habitat loss and degradation			
sea mounts, nutrient production, special along reef systems			Marquesas, Tortugas Bank, Islamorada Humps, Riley's Hump.	fixed sensors	
Knowledge of drivers for reef formation	reasons why reefs form in particular areas	management and conservation	Cuban waters	core sampling/analyses	

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Emphasis Area: Ocean Dynamics and Interactions					
Information Need - Approaches	Description	Key Benefits	Feasibility	Enabling Technologies underlined = need to develop	Partners / Available Assets
Impacts of underwater seep topography - seamounts/pinnacles/reef edges					
1 - vessel-based expedition (large vessel)	interdisciplinary observation, sampling, analysis (1m scale, fisheries, maps; microbial scale)	proximity to population centers; biological response	multiple expeditions required; "layered" approach & deploy long-term instrumentation	side-scan/multi-beam; <u>ROV/AUV/sub</u> ; multi-freq. acoustics; ADCP - fixed and towed); <u>video</u> (HDTV; 3-D); hyper-/multi-spectral optics (species ID)	AOML; JASON Project; HBOL; cross federal and state entities; ONR; DOI; USGS
2 - standard vessel expedition		highly dynamic regions (ex. Marquesas, west Florida shelf)	exploration applied at the "front end"	air/sea flux measurements; shallow water drifters; <u>remote samples</u> ; remote analyzers; deployed genomic monitoring; <u>develop real-time capability</u>	
3 - aircraft-based sensors	Remote sensing of surface & mixed layer reflection of topographic impacts	geologic areas of interest (Riley's Hump, Tortugas Bank, shelf edges of VI, Islamadora Humps)	first layer - high	airborne LIDAR; hyper-/multi-spectral optics (species ID); <i>in situ</i> ground truth	
4 - satellite-based sensors					
		graduate research areas; understanding of link to bioproductivity; ties to broad area biosystems; value to long-term sustainability (fisheries)			
Knowledge of Fisheries Habitats					
1 - vessel based expedition	class 1 vessel deployment	management; better ability to monitor impact of fishing; other disturbances;	high	standard suite" and develop acoustic techniques for classification (benthic, reef, and water column organisms)	congressional mandate; Univ Puerto Rico; Univ VI; state & regional; territorial agencies & councils; sport fishing; commercial fisheries; NURC; private industry (Ocean Fishing Forecasting Industry); FL Marine Labs (HBOI, MOTE); RSMAS
2 - aircraft	surface and near surface reflection of productivity, habitats, temp gradients, synthetic aperture radar, ocean color	target areas for research;	med	airborne LIDAR; hyper-/multi-spectral optics (species ID); <i>in situ</i> ground truth	
3 - space based remote sensing		ID key areas that may need production - "critical habitats";	med	same as aircraft; tracking of tagged fish	
4 - shore based deployment	small craft; coastal apps (20-200m)	ID new fisheries	high	light ROVs, AUVs, single beam acoustics, human diving technologies	
Understanding Ecology & Oceanography of FL Straits, VI, and Puerto Rico					
1 - vessel based expedition	class 1 vessel deployment	ID target areas for research;	high	"standard suite"	
2 - aircraft	surface and near surface reflection of productivity, habitats, temp gradients, synthetic aperture radar, ocean color	ID pollutants and their sources/transport (ex. HABs); ID new fisheries;	med	airborne LIDAR; hyper-/multi-spectral optics (species ID); <i>in situ</i> ground truth	state & local agencies; NASA (sat); SFOMC; Navy (NAVO, ONR); Univ VI; Univ Puerto Rico; RSMAS; local labs; USCG; INS; CIA (DESC); customs; NOPP; OCEAN.US
3 - space based remote sensing		ID linkages between fisheries (including sources, sinks);	med	same as aircraft; tracking of tagged fish	
4 - shore based deployment	small craft; coastal apps	management knowledge and resources;	med (distances)	light ROVs, AUVs, single beam acoustics, human diving technologies	
5 - fixed instruments and arrays	observations and observing systems	ecotourism; feasibility of energy conversion (public generation);	low (cost & risk)		
6 - drifters		Homeland Security; USCG (enforcement); environmental security	high	wide bandwidth communications (via LEO SAT)	
Microbial Interactions (Bacteria, Fungi, Protists, Viruses, Microalgae)					
1 - vessel based expedition	expeditions of class 1 vessels	knowledge of human impact on habitats and ecosystems; drug;	high (not real-time)	"standard suite" and preservation technology for deep samples; real-time remote analysis;	NIH; Public Health Service; Pharmaceutical Industries; global climate community; reinsurance & insurance industry;

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Emphasis Area: Ocean Dynamics and Interactions					
Information Need - Approaches	Description	Key Benefits	Feasibility	Enabling Technologies underlined = need to develop	Partners / Available Assets
2 - shore based deployment	small craft in coastal areas	Public exposure to benefits;	high	genomics; micro-arrays; conversion of molecular data to signals; real-time remote analysis	coastal management organizations
3 - Remote Sensing	use physical/productivity measurements as tip-off information	industrial products; human health; ID candidate research areas;	high		
4 - drifters		impact on global climate;	low (risk)		
5 - fixed sensors		understanding of relationships to pollutants, bioremediation	low (risk)		
Interactions between abyssal depths & shelf waters (Biotic & Abiotic)					
1 - vessel based expedition	expeditions of class 1 vessels	excite the public - "new frontier"; new organisms, biotech development; new products; areas of research; deep H2O impact of fisheries habitats; cultural and historical discoveries (locate shipwrecks); energy resources	med (high with deep dive capability or deployed sensor)	"standard suite"; deep submersible; deep ROV/AUV (multipurpose); surface deployed sampling/analysis devices (cost saving versus deep dive); low light optics	Japan; Russia; France; WHOI (ALVIN); US Navy; energy industries
2 - fixed sensor	bottom based			communications	

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Observation and Mapping					
Information Need/Gap	What	Why	Where	Technologies	Priority
6 Distribution and status of deep water coral reefs and fish stocks	distribution, taxonomy, abundance, condition, diversity, size	discover role in enhancing local species diversity; compare to known shallow reefs	PR, dry Tortugas, VI, Lang Bank, Shelf bank and wall at VI and PR, Nevassa Island, Columbian Banks	Submersibles, ROV's, advanced diving	16
27 Health and assessment of shallow water coral reefs - need the norms of conditions for comparisons	"Norms" (coral, fish, biomass) of condition for comparison	Major resource, tourist attraction, source of sediment for beaches, center of biodiversity of shallow waters	pan-Caribbean shallow water	visual technologies such as diving, develop new diagnostic or early warning technologies - molecular level technologies, remote sensing	13
3 How do you utilize more effectively, different mapping and imaging technologies to gain the information (large scale low resolution and small scale high resolution)desired					
8 Distribution and nature of submerged archaeological resources	Shipwrecks, prehistoric sites, submerged historical sites; determine nature of site and date it	Threatened resources due to profitability by others; addresses maritime cultural environment and colonial interactions and processes	Pan-Caribbean	All mapping technologies; develop ability to properly core and chemically characterize site; GIS to make successful and broad range availability	11
5 Discover and inventory new living resources (non-fishery) with commercial potential	taxonomy, chemical characteristics, molecular applications	discover and develop new bioproducts	Florida Straits, deep water habitats in Caribbean	submersible technologies; new sampling technologies - new probes, sensors, samplers (miniaturized); advanced diving	10
9 Biodiversity and ecology of marine caves	taxonomy, molecular genetics, mapping, chemical and physical characterization, geology, archaeology, biochemical characteristics	new and relatively unstudied ecosystems, high potential for discovery, critically endangered species, potentially new bioproducts	Bermuda, Bahamas, Yucatan, Greater Caribbean	technical diving, ROV's, mapping and GIS	10
19 Find new vents and seeps (includes fresh water seeps)	taxonomic, physical, same as deep basin	unknown exotic organisms, new insight into the evolution of life, every vent appears to be a bit different	Fresh water communities as well as marine, brine pools, Cayman trench, PR trench, any seismically active area	thermal mapping, salinity measurements, sonar, submersibles, multibeam, technical diving (?) in some of the shallower vents	9
18 Deep basins including PR trench and other Caribbean regions	biogeography, taxonomy, physical and chemical properties, geological work, sediment	unexplored regions	Caribbean basins (4), PR trench	submersibles, dredging, visual, trawling, trapping, coring, etc.	8
4 Learn status and habitats of spawning aggregations of fish	distribution, taxonomy, abundance, condition, life history	Very vulnerable to fishing, many already overfished; unique habitats and locations	PR, VI, Nevassa Islands, Columbian Banks (joint treaty)	acoustic work; optical; visual observations, mapping technologies; technologies that work at night	7
Ginsberg - Ultimate clients are those who live in coastal zones; what do these people in the 'summary' want?; not planning a systematic long-term study, just doing pilot projects that would show how we can fulfill the needs of our 'clients'					
Do we need to go back and inventory or go out and find new things? (Craig) Both valuable					
1 Status of fish stocks and habitat on the Islemorada Hump	distribution, taxonomy, abundance, condition, diversity	classically important fishing area; never been explored; been nominated as a marine protected area	Islemorada Hump, Florida Keys	ROV; stereo; digital video; submersibles, drift dives(?) advanced diving; passive acoustics	6
11 Coral reefs, beaches, archaeological sites, and fish, water quality as well - most important - coral reefs	information and define gaps	people relevant, food, economics, tourism	US EEZ: beaches - VI: pan-Caribbean for coral reefs; fish - closed areas and MPA's; archaeological sites Mona passage, Southern Bahamas, Florida Keys, Reef areas in general since lots of shipwrecks occur there	All technologies	6
12 Multibeam mapping of Ocean bottom; Adapt remote sensing from existing platforms and transfer to ocean exploration platforms to increase your sensor array capability	map	set baseline for ocean exploration	US EEZ: ID gaps such as vent and seep communities, drop-offs, trenches, reefs	multibeam technologies, sidescan, bottom profiler, magnetometer, others	5
15 Sea floor sediments Holocene (last 10,000 yrs)	what are they? How thick are they and what events do they record?	essential for understanding the history, sea floor habitats, beach deposits, anthropogenic factors	Florida deep water below 30 meters, VI, PR,	standard geological sampling; acoustics; develop new technologies - lasers, etc.	5
25 All taxa biodiversity inventory	species inventory	Not done	location where there is already a lot of information such as Florida Keys or Salt River Canyon in St. Croix (long-term hydrolab mission)	various sampling technologies, taxonomic expertise, systematics	5
16 Effort on developing automatic signal processing of data; openness with data - make accessible					

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Observation and Mapping					
Information Need/Gap	What	Why	Where	Technologies	Priority
2 Nautical charts from 15th century on - digitize and look at technology and scale to provide historical record ; look at evolution of technology	database - compile current info and map uncharted areas to add to knowledge	historical record of nautical charting, Shows historical progress and current needs	US coastal-wide; make this proposal driven to determine 'where'?	mapping tools and technologies	4
26 Knowledge of the diversity, abundance, and identity of marine microorganisms	taxonomic information, abundance, function, behavior	They are the most abundant organisms in the marine environment, control biogeochemical cycling, Not well understood	water, sediments, organisms, wide range of depths and areas	molecular tech, new culture techniques	3
10 Clearinghouse of existing ocean data and ID gaps; Dating service to connect those who have data with those who want it; connect those who want data with those who plan to collect it or have the means to do so - data library	Database , Lexus-Nexus of Ocean Data	Current means of data sharing are inefficient	Global US EEZ	IT technologies	2
20 Develop better coring technologies with AUV's or ROV's, and make it available					
21 Look at fragile ecosystems such as coastal estuarine regions in a new way so as not to damage them					
13 Deployment of permanent sensors to monitor events over long periods of time- gap is long-time data sets	could be just about anything; acoustic, all practical data types	lack of this type of data	surface and bottom of US EEZ; deeper areas; areas where there is high current flow, Medium sized bodies that are practical to approach	all sensing technologies, AUV's, any platform	2
23 Develop a sampling device to non-destructively sample and do in-situ analysis on that sample; for example - use AUV that doesn't have large payload to use syringe to take sample, run MCLS on it, do molecular genetics on it in-situ; in-situ processing; new ways to sample and analyze in-situ - miniaturized; take lab to ocean instead of ocean to lab					
14 Distribution and description of deep water habitat forming species; what species are forming the habitats? Get a map of the distributions of these habitat forming communities	identification of species and associated communities	these are probably the areas of high diversity and unique diversity counterparts to shallow water coral reefs and may be important for conservation and biological diversity; Doing more fishing in deep water areas - habitat degradation issues	pan-Caribbean	active acoustics, ROV's, submersibles, GIS	2
24 Distribution of marine geographic endemics	taxonomy, distribution, life history	many of the best studied groups have pelagic larval distributions - corals, shallow-water tropical marine fishes; may give us a much better understanding of evolution as well as extinction in the marine environment; applications to bioprospecting and biotechnology	Start at geographically distinct areas such as Florida Keys and compare to US VI	sampling techniques, molecular genetic techniques	2
17 Water/air interface - air/sea interactions - what can we observe on a small scale	biological, chemical, physical processes, tightly focused in terms of what's going on - fine scale	help us understand the uncertainties of global change and other global processes	Caribbean - hurricane source; pan-Caribbean in highly dynamic regions	develop new ones	1
22 Deep Diving and Long Range Marine Mammals	visual, optical, all senses, observe behavior, environment, habitat	unknown, Led us to interesting locations	Wherever they go! Several Caribbean wintering ground basins, nursery areas, feeding grounds	design new technologies - non-invasive and otherwise that follow these mammals	1
28 Exploration in time - how people have used (socio economic, cultural) the oceans in past and how has it affected present condition? Where are we heading?	historical records, Trading Patterns, Genetic Resources, Colonization of the Islands	to assess effect of anthropogenic factors on ocean resources	Pan-Caribbean	standard archaeological techniques, ethnographic data, Zoological techniques	1
Adapt remote sensing from existing platforms and transfer them to ocean exploration platforms					
Are the exploration of the Everglades and Estuaries considered part of ocean exploration?					
How do we prevent treasure hunters from using national maps to rob submerged archaeological sites?					

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Emphasis Area: Observation and Mapping					
Information Need - () Strategies	Description	Key benefits	cost/risk Feasibility	Enabling Technologies	Partners / Available Assets
1. Distribution and status of deep reefs and fish stocks					
A. determine where they occur - 30m-70m (technical diving depths) (funnel approach)	Use Bathymetry and Remote sensing to target areas, then make visual contact and dive	map, understanding of extent of deep reefs, inventory, trophic connections - how do they work? Understanding of major commercial fishery habitat to assist in management, education/outreach such as live broadcasts, resource management	High	bathymetry, remote sensing, multi-beam surveys, sidescan, technical diving, ROV's (?)	National Geographic, NSF, NURP, ONR, equipment manufacturers, other commercial operators such as major oil companies, UPR, UVI, USGS, Mineral Management Service (MMS), MBARI, NOAA center in NH
B. Target area and then explore >70m-300m	bathymetry, remote sensing, submersibles		Med	submersibles, remote sensing, bathymetry	Same as above
C. Start with existing knowledge and explore - shallow (targeted approach)	dive boats		High	technical diving	same as above; commercial dive shops, hospitality industry, cruise lines
D. Start with existing knowledge and explore - deep	submersibles		High	technical diving, ROV's, submersibles - location dependent	same as A
2. Health assessment of shallow coral reefs					
A. Well established standard diving techniques	one time visual assessment	scientific benefits - resource management, selection of MPA's, understanding of disease and impacts, biogeography, groundtruthing of remote images; industry benefits - fisheries, tourism, beaches; outreach - sexy topic for public, has potential for grassroot activism, tourism	high	SCUBA	tourism agencies, hotels, hospitality agencies, National Geographic, private foundations
B. Remote sensing	Aircraft and satellite sensors distinguish between dead and living coral		low	hypospectral techniques, aerial photography	NASA, NOAA, National Guard, Coast Guard, Navy,
3. Submerged archaeological resources					
A. Shallow water (funnel approach as well as targeted; non-invasive commercial exploitation)	Survey then standard diving and archaeological techniques same as shallow reef (2. A)	scientific - seabed mapping, shipwrecks are niches in and of themselves, potential for finding unique sites and resources, new insight into history and pre-history, new insight into development of technology; outreach - video clips, artifacts, inquiry, resource is 'sexy'; industry - non-invasive cooperation of commercial industry, enhancement to tourism and associated industries, museum displays	med-high	standard diving, acoustic, magnetometer	National Endowment for the Humanities, NSF, NGO's, National Geographic, private and corporate partners, affinity groups, Discovery Channel - media, academic partnerships - FSU, MIT, WHOI, TAMU, William and Mary, Univ of Bahamas, UPR; NURP, Smithsonian
B. Shallow Water Targeted Approach	Use historical records to select sites, then use standard diving and archaeological techniques		high		
C. Shallow Water non - invasive cooperation	cooperation between science, commercial, management to explore archaeological resources		low		
D. Deep water Funnel Approach	Survey then technical diving, ROVs, SUBs, and archaeological techniques		low	Add technical diving, submersibles, ROVs	
E. Deep Water Targeted Approach	Use historical records to select sites, then use Technical diving, ROVs, SUBs and archaeological techniques		medium		

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Emphasis Area: Observation and Mapping					
Information Need - () Strategies	Description	Key benefits	cost/risk Feasibility	Enabling Technologies	Partners / Available Assets
F. Deep Water non-invasive cooperation	cooperation between science, commercial, management to explore archaeological resources		low		
4. Discover and inventory new living resources (non-food species) with commercial potential					
A. Site Identification		science - discover new species, genetic and chemical diversity, bioactive compounds, new bioproducts, understanding role of compounds in nature; commercial - bioproducts, public disclosure of data; outreach - sexy topic, media coverage		bathymetry multi-beam and side scan	pharmaceutical industry, biotech, medical manufacturers, equipment manufacturers, USDA, cosmetic companies, NIH, NSF, NURP, Sea Grant, MBARI, WHOI, NASA, NCSNP, HBOI, SIO, UH, Smithsonian
a. Funnel Approach	High Resolution bathymetry to map deep water hard bottom areas. Use this information to identify sites		high		
b. Targeted Approach	Use Existing Maps to identify sites		high		
B. Sampling					
a. 30-150m	Tech diving and manual sampling		med-high	tech diving, manual sampling, develop new sampling tools and new tools to keep samples alive (high pressure, low temp containers)	
b. 150m to bottom	submersibles, ROVs, AUVs to collect samples		medium	develop new sampling tools as in above, submersibles	
5. Marine caves					
A. Approaches for Identifying Caves		scientific - new species, higher taxa, living fossils, most species endemic, potential for new life forms, potential links for deep sea, biogeography, evolutionary questions, genetic diversity, endangered species and habitats, archaeological discoveries, potential for chemical, geological, physical discoveries, new bioproducts, sea level history, tectonic info: industry - bioproducts, tourism; outreach - way cool, high adventure and high risk, exotic and historic artifacts, classic form of exploration - cave divers called explorers		technical diving, cave cam, develop new tools, all traditional sensors for collecting oceanographic properties, remote sensing, satellite and aerial photography, topographic maps, speak with cave divers, geological maps	diving - commercial operators such as charter boats, cave divers, fishermen, hunters
a. dive	visual observations while diving		H	technical diving	
b. oceanographic properties	look for chemical and physical signatures		H	traditional sensors, satellite photos, submersibles	
c. multibeam	ground truth with other methods to look for patterns		H	Multi-beam	
d. local knowledge	speak with locals		H	cave divers, fishermen, hunters	
B. Approaches for Exploring Caves					
a. Shallow (above 70m) and large (at least human size)	cave cam, AUV, remote samplers, drilling		high	GIS mapping, cave cam, drilling, data processing and visualization tools, sampling technologies, AUVs, Remote Samplers	
b. Shallow (above 70m) and Small	shallow small - cave cam on flexible cable, drilling core holes;		med - high	Same	
c. Deep (below 70m) and large (at least human size)	and add remote sensing; large deep ROVs;		med - low	Same (no diving)	same as last one and add taxonomists, many universities and museums all over world
d. Deep (below 70m) and small	small deep same as shallow small		med	Same, just different platform	

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Emphasis Area: Observation and Mapping					
Information Need - () Strategies	Description	Key benefits	cost/risk Feasibility	Enabling Technologies	Partners / Available Assets
C. Tie into geological drilling projects or other existing work to find micro-caves (partnerships with existing efforts)	find out who is doing what, and get the remains of core samples and work		med	coring, smaller tools (bore hole size)	Same add taxonomists
6. Vents and seeps					
A. Identification	same as caves but watch temp more	scientific - similar to caves and living non-commercial lists, unknown; industry also same but commercial benefits are less; outreach - way cool, earth's processes, water/land interface in the ultimate sense, great extremes	med - low		
B. Explore	time series photos, physical, microbial, chemical, biological sampling, detailed mapping		high	ROV's, submersibles AUVs, deployment of platforms that stay in place for long term monitoring, some new development of tools and platforms, cameras	same as last one but less commercial more foundations, possible oil and gas
7. Deep basin					
8. Spawning aggregations					
9. Fish stocks and habitats					
10. Coral reefs, beaches, fishes, archaeological sites					

Hawaii Workshop

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Ocean Dynamics and Interactions					
Information Need/Gap	What	Why	Where	Technologies	Interests
Understand the Pacific Ocean regarding the origin of life (vent communities, any optimal environments, etc)	interaction between geology, biota, circulation	Identify genomes - microorganisms, understand survivability, macrofauna and ecosystems, leads to detecting life elsewhere, relates to ourselves; how does life create itself	Loihi - volcano, hot spot; Juan de Fuca; cold seeps; Back Arc Basins (Guam, Samoa, Lau)	standard ships; ROVs; subs; sampling and incubation systems	11
Marine biodiversity - inventory from Hawaii Islands	link investigators to coordinate	Identify diversity; over fishing issues; biomedical opportunities; fishing issues	NW Hawaiian Islands to compare species; deep ocean areas	observatories at depth; deep ocean sampling instruments; low light cameras, video; acoustics; AUVs	9
Characterization of bottom habitats	match fish species to bottom characteristics; collect ground truth with deep tow side scan sonar; seafloor sediments characteristics; bottom currents	fishery population; food web; stock assessment (tuna issues)	Samoa; Marianas Islands	ROVs fly through; canyon fishing	7
Locating unknown seamounts	verifying location; sampling; mapping	spawning habitats; Earth evolution history	start comparing altimetry w/ nav charts	altimetry maps; swath bathymetry; fishing boat watching	7
Deep seamount biomass understanding	sampling; deep scattering layer over hydro plumes	spawning habitats	West Mounts; Neckeridge; Hawaiian Islands; Musician Seamounts		7
Gaps in exploration in past of arcs	less than 2% been explored; location of chemical fluxes and plumes; biotas; volumetrics; geologic signatures; tracing ocean circulation; sensing water column	plate tectonics, submergence, divergence, what initiates subductions; impact on variations on biomass and climate; mineral resources	euphotic zone in Tonga Kermadec Arc	ships, ROVs, AUVs	7
Understand habitat of large pelagic animals - migration corridors, use of ocean, vertical movements	attach instruments to animals - movements; fronts, eddies; interaction with benthos, linking foraging with physical environment	better management of living marine resources; fishery link between population and food source; mercury source	central Pacific (around Hawaii); coastal Kona (Big Island); ship of opportunity; Hawaiian Ridge	technologies attached to animals - archival tags, pop up satellite tags (PSAT), video; ARGOS	7
Natural history of Hawaiian Islands: geological controls on marine biota	what we don't know - seamount biology, why islands all different; geophysical history; how it ties into current optimal and extreme environment; landslide collapses; anthropogenic influences	how were they formed; future of human's impact; survival of islands ecosystems; speciation between islands	Hawaiian archipelago; surrounding pelagic waters; NW Hawaii - French Frigate Shoals; SE Hawaii - Big Island	multiplatforms; mobile observatories	6
Understanding biomagnification of pollutants and toxins in the marine food web (similar to large pelagic)		food source; nutrition; public health; ecosystem health	Kona coast; Ecuador; Peru; Alaska	tracers; genetic markers; sampling and ID tools; stable isotopes	5
Sample and map new hot spots; fundamental understanding	sampling deep mantle plume; sample volcanic edifice edge of seafloor	chemical fluxes; heat fluxes; Earth survivability; source of potable water	Samoa; Loihi	SOSUS; Isla - Infra Sound Lab (U.N.); bring back Hugo	5
Climate Change - feedback of ocean change on biota	studies in tone with El Niño events; long term; carbon fluxes in thermocline	impact on biological pump	Equatorial Pacific S. America; Galapagos; Toca Tao Arrays	genetic sampling; satellite (remote sensing); mass spectrometer; sediment traps/cameras	4
Trenches	gas hydrates	life under great pressures (barophiles)	Marianas Trench; Tonga Trench	deep diving vehicle	2
Data management of collected information, samples, etc - Directory (OE Catalog)	web sources; publics; displays; satellite links; presentations	information to the public	Bishop Museum; HURL; Reef Talk	video data management system; internet; sample catalog	

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Emphasis Area: Ocean Dynamics and Interactions			"standard" partners - UH, State of H, NMFS, NOS, NMS, USCG, Bishop Museum		

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
Understand the Pacific Ocean regarding the origin of life (vent communities, any optimal environments, etc)					
1 - Funnel (including Tow-Yos)	area to target (Tow-Yos - sampling in vertical)	mod (\$\$)	standard + specific sampling, HDTV, digital camera systems for culturing organisms	JAMSTEC, Univ of Washington, PMEL, NASA, GNS, COMB (Center of Marine Biology at Maryland)	genetic origins; biotech products; understand modes of life; outreach and education
Marine biodiversity - inventory from Hawaii Islands					
1 - Deep Marine (>200m - ~6500m or beyond)	along and around Hawaiian Ridge	mod (\$\$)	deep submersible; ROVs; benthic observatories	JAMSTEC; standard partners; ONR	preservation of species; outreach & education;
2 - deep ocean observatories	targeted at ridge; long term	mod (high tech challenge)	<i>insitu</i> observatories; self cleaning camera lenses	standard partners	understanding of wide environments; obs in natural environments;
3 - animal borne instruments	targeted and obs. Approach	high	critter camera technology; rugged low light cameras	National Geographic; NMFS; US Fish & wildlife services	marine mammal survivability; marine life/ecosystem management; ocean foraging
Characterization of bottom habitats					
1 - funnel	broad scale characterization	high	ROVs; swath; deep tow; remote sensing of shallow areas; acoustic surveys	Navy; WHOI; U.H. Mapping	stock assessment; fishing industry; understanding essential fish habitats
Locating unknown seamounts; Deep seamount biomass understanding					
1 - funnel	altimetry mapping comparisons; geoid products	high	better altimetry sensors and data processing; improved spatial coverage	NESDIS; NASA; Navy	mapping for fishing industry; earth science; Pacific plate evolution;
2 - target individual seamounts	moored stations; deep dives	mod (\$\$)	standard package; bio sampling; gravity survey; deep tow; AUVs	Navy	new fisheries; understanding fish spawning, topo. Bio. coupling, foraging, upwelling; fish migrations
Gaps in exploration in past of arcs					
1 - Tonga Kermadec - funnel, target, obs	standard plume techniques	high	airborne remote sensing surveys; XBTS, high precision; standard package, tow-yo	PMEL; GNS; JAMSTEC; NSF - ridge program;	mineral resources; plate tectonics; variations of biomass; oasis of life
2 - follow on obs. approach		high	ocean observatories	American Samoa; NMFS; NMS	
Understand habitat of large pelagic animals - migration corridors, use of ocean, vertical movements					
1 - targeted & observational	commercial/research vessels for tagging; satellite data comparisons for behavior patterns; acoustic subsurface surveys (foraging)	high	critter camera technology; satellite archival tags; ARGOS; remote sensing; acoustic surveys; instrument research	fishery council; Hawaii Long Line Assoc; National Fish & Wildlife; National Geographic; NIWA (New Zealand); CSIRO (Australia); SPREP (S. Pacific Reg. Env. Prog.)	fisheries industries; stock/resource assessment/mgt; international cooperation
Natural history of Hawaiian Islands; geological controls on marine biota					
1 - targeted	includes shallower water; land based influences; effects of high island; altimetry mapping comparisons; geoid products; hyperspectral surveys; high res. seismic surveys	high	standard package; airborne hyperspectral surveys; ground truthing	JAMSTEC; NOS; USGS; standard partners	marine resources; better maps; hazards issue
Understanding biomagnification of pollutants and toxins in the marine food web (similar to large pelagic)					

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
1 - observational	reef fishes; quantifying toxins	high	tracer technologies	EPA; standard partners	fishing industry; health; education
Sample and map new hot spots; fundamental understanding					
1 - targeted	Investigate Loihi, Samoa, Louisville Ridge	high	standard technologies; ocean bottom observatories; SOSUS, Sonobuoys Ocean Bottom Seismometer; Acoustic	USGS (Hawaii Volcano); GNS	understanding chemical fluxes, biomass
Climate Change - feedback of ocean change on biota					
1 - observational	time series with El Niño events: determine impacts on equatorial Pacific biological pump; long term	mod	fluorescent signal of phytoplankton species	standard partners	understanding biotic feedbacks on climate change; predicting/modeling changes on impacts
Trenches					
1 - targeted	Tonga Trench; deep dive mapping	high/mod	extreme deep diving for ROVs; sampling tech	JAMSTEC; NSF - Margins	plate tectonics; new species; subduction factory
Data management					
	develop catalog coordination; central catalog, clearing house	high	internet; digital process annotation	everybody	outreach and education

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Observation and Mapping					
Information Need/Gap	What	Why	Where	Technologies	Interest
23. Specific geological features					9
A. Submarine canyons	carbon cycling, areas of high productivity, ID and characterize communities, maps	not studied, area of high productivity, potential fish nursery habitats	Kaneohe Canyons, Haleiwa Canyon, Waimea Canyon	subs, ROV's, bait deployment, mapping	9
B. Seamounts	ID and characterize communities, ID new species	potential for new species - high speciation so could contribute to question of where species come from, potential stepping stones for species dispersal, evolution question	NW HI to start and then look outside to examine dispersal, evolution, many seamounts have no names, Emperor Seamounts		9
C. Solution Basins			off Maui		9
D. Banks			Penguin Banks, NW HI Banks		9
14. Current patterns and gyres and how they are changing	food production, marine debris deposits, how do they change and how are they affected?, larval transport	changes in ocean currents affect many things such as distribution of larvae, if can get a better handle on predicting changes, may be able to counteract problems associated with changes, fisheries management, early Polynesian navigation knowledge, cultural knowledge regarding dispersal of early Polynesians	HI Archipelago - large system focus	satellites, time observations, floating instruments, physical oceanography, molecular techniques to look at long-term dispersal patterns	2
13. Internal waves	physical oceanography, internal tides	how do these tides affect currents and impact distribution of marine life, mechanisms of upwelling, not well understood, may use this info to detect where coral beds and other suspension feeding organisms exist	sea mounts - 2002 proposal sites	ADCP's, long-term moorings	1
8. Paleoshorelines	sea level information such as history, finding wave notches, ledges, other geomorphological features, lava tubes and marine caves - biology	get a handle on sea level history, management - habitat as well as resource, chain is undiscovered, gain insight into rise and fall of islands	HI Archipelago (focus in NW and main islands - Midway, Oahu, Necker, main island, Brooks, Lisianski)	coring technology, advanced diving, subs and other vehicles, multibeam for mapping, animal borne instrumentation	5
18. Understanding population from geological records	fossil records, population over geologic time	better limits of yield	Kaneohe Bay		

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Observation and Mapping					
Information Need/Gap	What	Why	Where	Technologies	Interest
19. Extinct species (fossil reefs)	carbonate samples, date, taxonomy	evolution insight, biotechnological application	deeper the better, NW HI, Emperor Seamount chain, Kure and other seamounts up the chain	subs, manipulator, sample collection	
17. Marine parasite lifecycles	documenting parasites, life cycle, primary and secondary hosts	little known about them, bound to find new species	compare regions to look for pollution relationships, NW HI	fishing, sampling technology, subs, genomics, histopathology, specimen collection	3
15. Pollution and marine pathogens	pathogen count as a marker	organisms getting sick, human impact	event driven, Kaneohe Bay, Pearl Harbor, sewage outfall	molecular biology techniques, genomics	1
1. Submerged archaeological sites	location, material remains, priority areas, identify microbial community of sites to determine age, dating, erosion control, biological climate, identify and catalogue biological community	historical significance, to eliminate potential for activities that might jeopardize artifacts such as looting, dumping, etc, Federal Abandoned Shipwreck Act of 1978, looting a problem in Hawaii, ecological impacts, tourism	Kure Island - one of most significant wrecks in Hawaii - Naval Historical Center probably interested in this site; protected zone off Pearl Harbor - several subs there - historic landing sites; Nihoa Island and Necker Island; wider Pacific; US Insular Pacific; Hawaiian Islands - Oahu, big island Hawaii, Kure, Pearl Harbor, Midway, Lanai (shipwreck beach)	side scan sonar, magnetometer, technical and advanced diving, ROV's, subs, aerial survey or remote sensing, technology dependent on location and type of wreck - later . . . excavation, conservation, and display - need conservation facilities, microbial technologies, microchip technology	12
5. Animal distribution patterns	all life stages - larvae through adults, population structure, corals, charismatic megafauna (sharks, whales, dolphins, seals, sea turtles)	resource management, because they are there, connectivity questions, tourism	HI Archipelago (Hoomalu and Mau regions - have at least one site in each region, also big island site), specific relationship between main HI and NW HI and between Johnston Atoll to S. Japan, island to island, bank to bank relationships	tracking devices, genomics, develop new faster genomic technologies to be used on ships, current meters, ADCP's, molecular techniques to ID larvae, video technology, time lapse photography	12
3. Identifying ecologically critical habitats	diversity, location, substrate type, visual information, reflected imagery, community structure	some will be important to fisheries, to protected species, establish links to undersea landscapes	intermediate depth regions, wide range of depths - mostly moderate depths to deeper depths, NW HI Islands - 2002 sites as specified in 2002 proposals, US Pacific Insular Islands, Guam, Samoa, CNMI	archival capability, current meters, ADCP's, multibeam . . . Same as above, tagging technologies	9
4. Formation of biofilm/microbial mat in extreme environments	diversity, members of consortia, genome mapping, discovery of new antibiotics, chemistry of the environment	origin of life questions, biotechnology	Loihi hydrothermal vent, New Zealand, Marianas Trench, any extreme environment	coring technology, genomics, protein chemistry, microchip, confocal microscopy, develop portable confocal for ship use, small gc/ms, subs and other collection vehicles	8
2. New species/records inventory	abundance and diversity, taxonomy	very little is known about this region and it is now a huge reserve, beginning sanctuary designation process, bioprospecting, may need additional levels of protection on certain rare species - management	NW HI (2002 proposal sites) - far islands such as Kure and beyond where there have been no subs thus far, get close to N Pacific transition zone, US Insular surveys, maybe look at some equatorial areas for comparison	same as above with multibeam added	6
10. Active volcanism	ID sites, composition, geological properties, biological properties, chemical properties, plume characteristics	sites of very interesting organisms - extremophiles, geological interest, creation of islands	Am. Samoa, New Zealand, Japan, CNMI, Guam - throughout Pacific	thermal technology, magnetometers, seismology	5
6. Ocean acoustics	unique species fingerprints	benthic habitat, describe acoustic landscape including inverts marine mammals, etc, calibrating, unknown	HI Archipelago (NW and main HI mapping), Guam, CNMI, Am. Samoa, deeper areas	sonar - active and passive, use subs and other vehicles for insitu measurements, archival measurements	4
21. Ecosystem interactions	trophic level interactions, define where gaps are	to better understand for ecosystem management purposes	primary productivity to infauna	will vary, stable isotopes, fatty acid analysis, modeling	4
7. Library of community DNA	DNA archive	can collect this info during cruises	all communities	DNA storage technologies	3
9. Mineral resources	location, composition	resource management, commercial value, can contribute to knowledge of geologic history	Johnston sea mount, other sea mounts	subs and other vehicles, multibeam	3

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Observation and Mapping					
Information Need/Gap	What	Why	Where	Technologies	Interest
16. Charting of seamounts and banks	mapping with more sophisticated technology	Some NOAA charts are not accurate	all submerged banks, particularly those that can't be seen through aerial photography, NW HI at 25-100 fathoms	multibeam	3
24. Coelocanth, giant squid, megamouth (obscure, unknown critters)	location, habitats?, population distribution, abundance, genetics, images	exciting new species, know nothing about them, future funding and outreach - PR, evolution questions	Indonesia (coelocanth), HI, California (Pacific) (megamouth), New Zealand (giant squid)	imaging, subs, ROV's	3
22. Marine viruses	what effects on carbon and phosphorus cycling	to understand their effects on carbon and phosphorus - looks like they may take up all the phosphorus	Oahu, Station Aloha (permanent sampling site - mooring)	water sampling, virology, bacteriology, molecular biology techniques	2
11. Locating and removing unexploded ordinances from coastal regions		there are lots of 'bombs' in coastal regions and Navy is all talk and no action on subject			
12. Safe nuclear waste disposal site					
20. Infaunal organisms	taxonomy, sediment ecology	discovery of new species, not well understood, relates to carbon cycling	compare NW HI to others down chain, different depths, soft bottom	sampling, multibeam, coring, subs, diving	

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs	
Emphasis Area: Observation and Mapping	standard partners for State of Hawaii - UH, NMFS, DLNR/DAR, NOS, Sea Grant, HURL, West PAC, Bishop Museum, DOE, Fish and Wildlife Service, Navy Historical Center, National Park Service, USGS, Coast Guard, ONR, NSF

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
1. Submerged archaeological sites					
A. Near-shore low impact visual survey - Targeted	historical research, archives, non-invasive documentation	H	small vessels, aerial survey	Standard plus the following: Naval Historical Center, National Park Service, National Geographic, Discovery Channel, DOI, State Historic Preservation Division, Hawaii Historical Foundation, Hawaii Community Foundation, Bishop Museum, CMAR, other small NGO's, Smithsonian	scientific - in state and federal laws that historic vessels are to be protected; industry - tourism; outreach - lots of public interest, education, stewardship of cultural resources; regulatory - protecting areas
B. Mid-water remote sensing	documentation to narrow down to select survey areas, groundtruth targets	H	vessels, sidescan, conservation ability		
C. Deep water	survey targeted areas then groundtruth	M	standard package, conservation ability		
2. Animal distribution patterns				Standard partners plus fishermen - recreational and commercial	scientific - new knowledge, don't have a good handle on larval stages, biogeography, connectivity; regulatory - management; industry - commercial fishery; outreach - public interest, sexy topic, stewardship
A. Opportunistic (fisheries) Adults only	tagging through existing operations such as fishing industry	H	tags		
B. Targeted tagging adults	mark-recapture of marine mammals, photo ID	M-H	standard package plus tags, cameras		
C. Targeted tracking adults	track over time with tags and acoustic moorings	M-H	standard package and/or RAPT system for tracking, tags, cameras, ADCPS, time-lapse photography, aerial survey, digital ID tools		
D. Genomics (can be part of tagging and/or tracking)	collect tissue and analyze	M	standard plus genetic tools		
E. Otolith elemental fingerprinting	collect specimens through HI Arch. and analyze	L	fingerprinting tech		
F. Larval distribution patterns	collect and ID samples	H	plankton tows		
3. Specific geological features					
A. Survey	survey, map, groundtruthing, sampling, direct observations, ID and characterize organisms as well as features	H	standard package, genomic technologies, coring, molecular techniques; video live feeds for outreach, Hugo at Loihi volcano; dating technologies	standard partners, HUGO, telephone companies, outreach partners, National Geographic, Discovery Channel, drug companies, MMS	scientific - history of HI, ID new species, species dispersal, evolution, biogeography, ID new habitats; outreach - public interest, lots of opportunity; industry - fisheries, minerals, biotechnology
4. Extremophiles					
A. Targeted approach for ID purposes	known vents, trenches, seeps, cold water, fish guts	H	standard package, coring		
B. Characterize	ID through genomics and other molecular techniques	M	genomics, protein chemistry, GS/MS, need to develop better technology, bioreactors for culture purposes	drug companies, biotech industry, standard partners	scientific - new products, origin of life
5. Ecologically important habitats					

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
A.Temporal/spacial observations	observations over time	M	Standard package plus, ADCP's	Standard partners plus outreach partners, fishermen, National Geographic, Discovery Channel	Scientific - biogeography, biodiversity, ecosystem interactions, community structure, management, restoration; industry - recreation, fisheries; regulatory - reserves, management
B. Funnel approach	mapping, then direct observations	H	Standard package plus	Same as above plus recreational divers	
C. Animal borne camera system	locating critical habitats with critter cam system	H	may need standard package, camera system	Same as above	
D. Targeted approach	use existing and historical information	H	may need standard package	Same as above plus recreational divers	
6. Active volcanism					
A. Access naval data		L	Standard package plus passive acoustic arrays, live feed for outreach	Standard partners, Navy, National Geographic, Discovery Channel, deep sea mining community, New Zealand, Japan, Island Nations, Indonesia, Australia, maritime industry, biotech, minerals	scientific - extremophiles, origin of life; industry - minerals, biotech; outreach - lots of public interest
B. Airborne geochemical	track plumes and trace elements from plumes from air, funnel approach	M-H	Standard package plus remote sensing		
C. Seismic		M	Same as above plus seismic technologies		
D. Passive acoustics	set up listening arrays	L	Same with acoustic tech.		
E. General mapping	locate features using mapping technology	M	mapping tech		
7. New species ID (macro and micro)					
A. Opportunistic	ID new species through existing expeditions	H	Standard package plus molecular and genomic techniques	Standard partners plus fishermen, Smithsonian, New Species Consortium, Sloan Foundation, National Geographic, Discovery Channel, Packard Foundation	scientific - origin of life, evolution, census of marine life; industry - biotech; outreach - can be a really big deal so huge public interest; regulatory - management
B. Targeted - geographic	going to areas and habitats that are not well documented	H			
C. Targeted - organisms	examining organisms for new organisms (parasites)	H			

Alaska Workshop

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Information Need/Gap	What	Why	Where	Technologies	Interest
Fjords of southeast and southcentral Alaska, especially the deep and dynamic ones (Hooge)	Contrast recent glaciated landscapes to more stable and tidewater to non estuaries. Tidewater glacial vs nonglacial.; Substrates for habitat mapping. Detection of species distributions. Determining some of physical and biological effects of deglaciation. They have complex oceanographic regimes and teasing out would be good.	Intense fisheries issues, MPAs establishment, emerging landscapes, often extremely dynamic. Lots of opportunities to leverage off of other studies in these areas. And lots of opportunities to have strong outreach component e.g. cruise ships. There are also recolonization issues e.g. following biocatastrophe; Isostatic uplifting.	Glacier Bay, Prince William Sound, Icy Bay.; Substrates for habitat mapping.	Multibeam, groundtruthing including submersibles, ROVs, AUVs, and oceanographic sampling with CTDs, ADCPs; divers; ships of opportunity	1
Documenting climate variability (Molnia)	500 million year record of global climate. Need to examine it to look for variability	Is human activity changing the Gulf?			1
Glaciers (Molnia)	How did the glaciers existing in the Bering Sea change over time?	Not well understood	Gulf of Alaska continental shelf between Cook Inlet to Canadian Border	Sediment sampling, ROVs/Dives, high resolution geophysics	1
Explore environment created and released by retreating or advancing glaciers	sample; identify; characterize	fresh water inputs to ocean; consequences of rapid glacier retreat	southeast Alaska Glacier Bay	surveying bottom sediment; sampling	
Characterize / explore extreme environments	high salinity / low temp environments	identify new species and novel protection mechanisms against extreme conditions	Bering Basin / Arctic Ocean	extreme cold technology; sampling; biochemical genetic screening	
Aleutian Trench	Geology (improved mapping), corals, habitats, inventory, Methane seeps, trophic systems, new species	Possible feeding dynamics, possible resources in shallow areas, deep water coral communities for fish habitat, major subduction zone that is unexplored	From start to very end of Aleutian Chain	Mapping, multibeam ROV/AUVs, sediment sampling - coring; video	2
Aleutian Arc	structural arc; substrates; patterns of coral distribution; hydrothermal venting; Biodiversity, biology, and oceanography, volcanism	Geologically active, submarine volcanism; strong current habitats; migration issues	Region between the islands and north of the Arc. (abyssal plain); From southern boundaries of the platforms, north to abyssal plain of the Bering Sea	Sediment sampling, "everything", seafloor mapping, rock sampling, water column methane sniffing. AUVs for mapping broad shallow areas of continental shelf. Much better than using surface ship. MBARI has developed vibracoring system which could be adapted for this project.	2
Large Physical Features - Aleutian Canyons (Yogodzinski)	rate of the consumption of the physical plate; geochemistry; sediment transport; volcanism; biology of area; hot springs seeps; very interconnected physical systems.	important area that is poorly characterized; very systematic changes occurring along chain due to shape; Dynamic physical system; Integrated physical system and its connection to biology	Southeast Alaska, Aleutians; Deep Canyons in Aleutian Fore Arc (POC - Phillip Rigby and Gene Yogodzinski); Bogoslov; near subvolcanoes	Multibeam, manned and unmanned submersibles (7000 m), technology that allows you to hold station in strong current.	2
How do breaks in the shelf edge (canyon) influence the distribution and abundance of species; are they the locale of novel species assemblages	survey and sample a suite of canyons	may be important areas for production of fish or advection of deep-dwelling species onto the shelf	canyons in Gulf of Alaska, Aleutians, Bering Sea	trawls; nets; sampling; visualization techniques; physical oceanography tools	
Bering Sea Canyon	Geology (improved mapping), corals, habitats, inventory, Methane seeps, trophic systems, new species	Is human activity changing the Gulf?; Interaction with shallow water	Bering Sea Canyon; Kodiak Seamount	Mapping, multibeam ROV/AUVs, sediment sampling - coring; video	3
Continental Rise and the Outer Continental Shelf, right down to the Abyssal Floor Plain	Biological communities, geologic history, record of continental climate	Least studied part of the ocean, a place where the bigger tsunamis may be generated from slope edge slumps,	arc of the Gulf; Gulf of Alaska continental margin, Bering Sea, e.g. at the base of the margin cutting the canyons,	Suite of geological and biological sampling devices; underwater positioning	3

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Information Need/Gap	What	Why	Where	Technologies	Interest
Hydrographic, bathymetric and tidal data - mean low and high water (Baird)		Not mapped; not enough resolution in existing maps; Tidal data to establish boundaries; how sea data changes with events	Western and northern Alaska; Bristol Bay, Arctic Basin, Bering Sea, Bering Strait, Bering Sea (data gaps areas)	Side scan, tide gauges; Backscatter processing, mapping	4
Bering Sea Fish Habitats (McConnaughey)	Bathymetry - sediments, habitat; hydrography; tidal data; biology (temporal)	Lack basic information; Areas will not be looked at by other organizations; high variability habitat; Very important spatial gaps; Temporal gaps; e.g. near shore, Bristol Bay was home of most valued single species in world at one time. Oil and gas interest in the area. Truly unknown undescribed areas.; high value commercial species	gaps in data of Bering Sea - Bristol Bay	What is relevant scale?; Issues: uncoordinated, overlapping mandates. Classified data and getting access to it; Ships of opportunity as technology. Interferometry.; multibeam; sidescan; backscatter	4
Catalogue the distribution and abundance of the types of species that are in the mesopelagic zone, benthic habitats that support important ecosystem components including fish and rare or special species and essential fish habitats	what is the importance of these features for maintaining biodiversity; cataloging; features; mapping	MPAs; fishery restrictions; critical ecosystem; resources; critical resource of high trophic level organisms (big fish, birds, mammals)	continental shelf; Gulf of Alaska; Bering Sea; Chukchi Sea; shelf edge and basin of Gulf of Alaska	bottom profiling technologies; optics; satellites; nets; tagging; underwater visual technology; PSATS	
Gain knowledge and understanding impacts of essential fish habitats; candidate areas of protection	benthic habitats; mapping; photography; inventory	role in supporting ecosystem spawning	Pribiloff Canyons; between Aleutians and shelf break		
Seasonal exploration	Biological, geological, cryosphere, biological and physical oceanography,	Completely unknown and potentially very biotically important	Continental Shelf spawning area, Bering Sea (Bristol Bay, northern Bering Sea e.g. along the ice edge, central Arctic Basin, whole ice edge), Cook Inlet (issue - other organizations working on it).	Icebreakers, submersibles, remote sensing, full blown submarines, multibeam	5
Sea Ice in Bering, Chukchi and Beaufort Seas (Pawlowski)	Biology and physical processes going on. Ballena studies. Increased fetch. Change in migration patterns.	Change in ice distribution. Climate response issue. ; Major rookeries for pinnipeds and seabirds. Bering Sea is in an ecosystem crises.	Nearshore reefs e.g. Camden Bay. Along Arctic barrier islands. Some of the Bering Sea Islands for coastal erosion.	Remote sensing whether airborne or other. Mapping tools. On vessels of opportunity.	5
What is the role of sea ice cover in structuring the marine ecosystem; how does this vary with latitude of the edge; how does the ice cover link the Arctic to the Bering Sea	what organisms are present and how they vary between regions?; ice characteristics (thickness, structure, etc.); exchange with water column	sea ice is believed to play a critical role for production of shelf ecosystems; predicted to diminish; cultural asset	Chukchi Sea; Bering Sea	ice-going vessel; remote sensing - satellite; ice moorings; autonomous platforms	
Plate Boundary - Strike Slip System	mapping, water column survey, id and characterize; Taxonomy	Neotectonics, seeps, compare w/ other plate boundaries. Large earthquakes, sediment slides. Not well documented; Possible coldwater petroleum seeps	Icy strait - Canadian border to Alek River. South of Icy Strait. Fairweather Fault; Yakutat Terrain	Cameras, ROVs, AUVs, ADCP, multibeam	6
Intertidal Zones	Biodiversity, taxonomy, ID and characterize. Archaeology.	Not documented. Remote nature, add value to other studies.	Aleutian Islands, Islands in Gulf of Alaska e.g. Shumagins, Kodiak Island Group; Alaskan Peninsula	Via helos from ships, Alaska Peninsula, standard biological sampling, LIDAR,	7
Acoustic Monitoring	seismic acoustics; fauna acoustics; Marine mammals, fish, migration paths	New way to look at ocean, learn a variety of things	Aleutians, SE Alaska, Aleutian Arc, Bering Sea,	Hydrophones, observing system(s),	8

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Information Need/Gap	What	Why	Where	Technologies	Interest
Submarine Seamounts	Evolution of seamounts. Circulation and currents.; ecosystems; deep water	Unique ecosystems, centers of upwelling, unique species, unique trophic systems, food webs	Southcentral Gulf of Alaska (Gulf of Alaska Seamount Province) e.g. Pratt-Welker Chain, Patton Murray Chain, South of the trench (e.g. Adak Island, Central Aleutians, Atka Island).	ROVs, submersibles, new technology (e.g. video to speed up processing) Issue - need automated processing of video data. High definition video. multibeam.	9
Traditional Knowledge	Western science vs native observations, compare life histories of animals	The value of the data sets, extend the time series	Hada Villages in SE, Traditional grounds of Hoonah Village, Tlingit village, St. Lawrence, Northern Bering Island	Interviews, archaeological tools, biological sampling, multibeam, LIDAR, side-scan sampling	10
Circulation Survey	subsurface current	Benthic organisms, distribution of nutrients	Western Alaska, Nome, Bering Sea, Chukchi Sea	ADCP, moorings, remote sensings,	11
WWII and Later Human Sites	Location and characterization of site, artifacts ; Effects on ecosystems and food chain	Environmental impacts, history, need for potential cleanups; protect sites	Western Aleutian Islands, Kiska Island, Duke Island (SE AK), Attu Island,	Diving, side-scan, multibeam, archive searching	12
Pre WWII (Gold Rush ships)	Location and characterization of site, artifacts ; Effects on ecosystems and food chain	history, protect sites	SE Alaska, Lynn Canal	Diving, side-scan, multibeam, archive searching	12
Location and understanding hazard dumps; characterization	determine location; chemistry of material	potential biohazard	Aleutians	hazard sampling techniques; underwater moorings	
Continental Margin (shelf and slope) of the Beaufort Sea	Bathymetry, navigation hazards, biota	Arctic path for shipping. Unknown biota	North of Sag River, entire shoreline of Beaufort Sea, Cape Lisbourne	Partnering w/ others, single channel sidescan, multibeam, fathometers in shallow water, LIDAR,	13
Archaeological Information on Human Migration	Sites of ancient villages, possible migration routes, ice records,	To determine if that was the major migration route for humans	Fairweather Ground	Multibeam, ROVs, very high resolution side-scan "pseudo sidescan" (backscatter),	14
Gas Hydrates	Interaction w/ ocean. ID and characterize communities associated with them. Distribution and location.	Two orders or more of Methane (is it recoverable?), more methane than other fossil fuels,	Deep Gulf of Alaska, Beaufort, North Slope, Chukchi, Wrangall Island.	Seismic profiling, sniffers, gas profiling, sidescan	15
Identify and catalogue the trophic webs that support birds and mammals in the wintertime; look at what physical processes impact their system	what zooplankton are available for species dependent on their food type; water column biology (zooplankton); ocean physics; sampling	many birds and mammals spend winter in Bering and Aleutians, but know little about what they eat there; supports endangered species; food web dynamics info	South Bering Sea; Aleutian Islands (wintertime)	biophysical moorings (winter); new sampling technologies under high sea states	
What are the abundant and important microbes and micro-zooplankton of the Bering and Chukchi Sea; Gain knowledge of ecosystem health; long-term variability	microbiology and micro-zooplankton sampling	these organisms likely play critical role in function of ecosystem	Chukchi Sea; Bering Sea	specialized sampling and growth chambers; microscopy	
Information on microscopic interfaces of chemistry, microbiology (liquid-solid interface)	explore unknown micro- / nano-environment; characterize it	lack of understanding; changes affecting ecosystems and ocean productivity; role in producing biocompounds and enhancing biodiversity	shelf, shallow water	microsampling; micro- and nano-technologies	
Where do high latitude organisms go to spend winter	support for designation of critical habitats	vulnerability of birds, mammals	Polynas - St. Lawrence, Sereniki, St. Matthew	biological and physical tools; benthic sampling	
Need data and information on large-scale circulation and variability of Beaufort Gyre	explore largest freshwater reservoir	one of largest fresh water reservoir capable of influencing global climate; accessibility problem	Beaufort Sea / Arctic Ocean	remote sensing; autonomous platforms; ice-going vessels, moorings	

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Emphasis Area: Bering Sea, Aleutian Arc & Trench, Gulf of Alaska (including seamounts, fjords, continental margin), Iced Areas					
"Standard" Partners - NOAA (OMAO, NESDIS, NOS, Coast Survey), NURP, NMFS, AFCE, NOPP, U of Alaska, Oregon State Univ, UNOLS Community, Alaska Native Science Communities, MMS, USGS, Prince William Sound Science Center, North Pacific Research Board, US Fish & Wildlife					

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
Bering Sea					
1 - funnel	characterize sea beds;	high		USGS; commercial; NMFS	salmon disaster; fisheries issues
Bristol Bay; open water	bio and physical systems; surveys; currents; sediment transport; groundtruthing		standard package; multibeam; LIDAR of seabed; multibeam; imaging; video		global ecosystem (high priority of Bristol Bay)
2 - observation	collecting tidal info.; sampling; groundtruthing	high	standard package; high resolution; research trawls; HDTV; moorings; sampling; grabs/corers; seasonal moorings	standard partners; fishing industry	characterize undiscovered areas; essential fish habitats
Bristol Bay					
3 - funnel		high	ROV; seafloor surveys; current meters	standard partners; bilateral explorers	undiscovered; understanding hazards; undisturbed habitats; productivity of Bering Sea; bilateral exploration
canyons	surveys; sediment transport; biological, physical oceanography; climate history; benthic biology; cold seep environment				
Aleutian Arc & Trench				USGS, AVO	undiscovered areas
1 - funnel					
trench transect	surveys of structures on Pacific Plate; deep trench; seep communities; biology; slumps (sub landslides)	high (though depth limit)	deep vehicle capabilities; high pressure samplers; deep tow; rock dredging	JAMSTEC	characterize dynamic environment and connecting to biological communities;
canyons	sediment transport; bedrock geology; benthic biology; thermal venting; physical oceanography;	high (though strong current problems)	station keeping for ship & vehicle		unique area; gateway thru Bering and Pacific; understanding earthquake and tsunami hazards;
Aleutian Ridge; shallow water	thermal vents; structures; chemistry of hydrothermal system; vulcanology	high	vent samplers; acoustic monitoring		undisturbed ecosystems
environment of passes (central and western Aleutians; Adak to Kiska?)	benthic and physical oceanography	mod (strong current problems, tidal range)	CODAR (new tool)		
Aleutian Back Arc	thermal vents; structures; chemistry of hydrothermal system; vulcanology	high	acoustic monitoring	US/Russia	
Iced Areas		lots of challenges - darkness, extreme temps, ice, storms			
1 - wintertime exploration	Bering and Chukchi				
biology	survey migration of seabirds & mammals	low	wildlife tags; remote sensing - satellite;	industry; Navy; US/Canadian/Russian Coast Guard; Native Communities;	economic significance of fisheries;
distribution & abundance of biota			AUVs; ice breaker ships		migration behaviors knowledge of marine mammals;
ecology of mammals and fish					

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
2 - survey of bottom & circulation of perennially covered ice areas	deep water	low	aircraft for cold weather	NSF, Arctic Logistics; BASC (Barrow Arctic Sci Consort); VECO Corp.	understanding climate variability;
3 - observation	spatial and temporal observation	mod	acoustic monitoring, National Technical Means; thermal imaging		filling gaps in knowledge
Gulf of Alaska					
1 - fjords (targeted surveys)	deep water; high current areas; ice face; rapid deglaciated areas; archaeology	high - deep water, rapid deglaciated areas; mod - high current areas & ice face	ROVs; AUVs; HDTV; remote sensing - satellite (ASTER, LANDSAT 7)	cruise lines	threatened species, sources of mortality fisheries; MPA issues; tourism - public interest
2 - outermost continental margin (targeted)	outer shelf slope valleys; high resolution surveys; abyssal plains; physical oceanography; hazmat dumping; climate history; biological communities; cold seep environment; gas hydrates	high	multibeam; deep tows; gas hydrates - seismic reflection, sidescan/backscatter, water column surveys	various commercial companies; Navy	undiscovered areas; characterizing unique environments; understanding submarine landslides / instability
3 - strike slip plate boundary	locating cold seeps; natural hazards; cold water petroleum seeps; neotectonics	high	ROVs; basic surveying tools; standard package	Canadian Gov't (Earth Science Sector); Petroleum Corps	natural hazards; unique nature (chemical nature and corresponding biology)
4 - seamounts (targeted surveys)	benthic and pelagic biology; biological hot zones; history of seamount; physical oceanography (currents change); undisturbed sediment accumulation on summits; upwelling zones	high	ROVs; ADCP; detailed mapping & sampling; trawling gear (700m)	Navy; MBARI	ecology of undisturbed ecosystem, fisheries; refuges/isolation
Archaeology					
1 - Gulf of Alaska (Cape Spencer to Cape Suckling - west of Juneau to SE P.W. Sound) - funnel;	broad survey; high resolution survey	high - location; low - recovery	multibeam side scan; ROVs; human diving; special equipment for artifacts - lab facilities for preservation & stabilization	museums; salvage org, MMS	history; human interests
2 - inland water S.E.; Aleutians; Bering Coast;	WWII; gold rush; whaling	high - location; low - recovery	multibeam side scan; ROVs; human diving; special equipment for artifacts - lab facilities for preservation & stabilization	museums; salvage org, MMS	history; human interests

West Coast Workshop

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Ocean Dynamics and Interactions					
Information Need/Gap	What	Why	Where	Technologies	Interest
Knowledge of the deep sea water column (largest biomass on planet)	biota - what organisms exist (distribution, abundance, dynamics)	unknown, undiscovered, unexplored; evolutionary relationships; size and volume of habitat; unknown result of human impact; linkage of slope and shallow water; trophic linkage between protected and other species; carbon flux; linked to inorganic processes; link to climate change	bottom mixed layer to sea floor; deep water North Pacific on coast	imaging - HDTV & holographic; nested acoustics techniques; continuous capability; capturing particle flux; genomics on a chip	21
Biological oasis hot spots	discover, inventory biota; explore; identify processes; find new areas	discover; biodiversity	seamounts, canyons, upwelling; ocean frontal zones; river plumes; seafloor hydrothermal vents	imaging - HDTV & holographic; nested acoustics techniques; continuous capability; capturing particle flux; long-term & long-standing observatories; coring; genomics on a chip; generation of sampling technology (give 100x more data) ; genetic markers on AUVs; remote sensing technology on AUV; real time capability; chemical sensor; PSATS; electronic tags; acoustics; acoustic mapping; ROVs; sampling systems; video; sub; long-range AUVs; sensors for gas analysis; higher resolution chemical sensors; long-term instruments that can survive in the canyon environments; temporal exploration; physical ocean modeling; genetic probes; insitu visualization; observation techniques; fiber optic observatory	16 16
Habitat on nearshore (shelf and slope); Archaeological paleoclimate area	understanding of flows of chemicals; fisheries; understanding biological hot spots; sediment transport; physical, current flow interactions; discover history influences; understanding margin marine boundary layer	intensive human impact; link of chemistry and biota	0-1000m depth; 0-100m transport	generation of sampling technology (give 100x more data); genetic markers on AUVs; remote sensing technology on AUV, etc; real time capability; chemical sensor	15
Plate scale to mesoscale observatory; long-term understanding of episodic events	absorption of CO ₂ ; long-term; needs thorough mapping effort; collaborative effort; new ways to do oceanography; understanding fluid flux productivity of subduction zones; sources of interplanetary life	Scientific CNN; opens temporal domain; resolves limitations of surface vessels; interactive telescope into inner space	observe 50-70km	fiber optic observatory	13
Canyon systems, gulleys (physical, chemical, biology systems)	turbidity currents; internal waves; bridge from shelf to deep sea; develop proxies of variability over time in sediments	cable routes; essential fish habitats; biohazard dumping; grocery run for deep sea organisms	west coast; Big Sur Canyon Complex	long-term instruments that can survive in the canyon environments; temporal exploration; physical ocean modeling	11
Productivity of ocean in euphotic zone	discover new members; <20 microns (includes viruses, parasites); spatial structures (scales); need balance equation	HABs	euphotic zone; Central Gyre; Monterey Bay	genetic probes; <i>insitu</i> visualization; observation techniques	10
Knowledge of the deep sea floor	biosphere at seafloor; benthic community; crust & microbial communities; i.e. all deep sea floor communities	earth's history; proxies to understand sediment records; simultaneous process documentation over a decade opens the door to millennium; crustal processes compared to other planets; link to climate change	bottom mixed layer to sea floor; deep water North Pacific on coast	imaging - HDTV & holographic; nested acoustics techniques; continuous capability; capturing particle flux; long-term & long-standing observatories; coring; genomics on a chip	9

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Ocean Dynamics and Interactions					
Information Need/Gap	What	Why	Where	Technologies	Interest
Pelagic animal movement and orientation	how the populations succeed; behavior patterns; interactions with ocean structures; use of habitat; range and navigation	discovery and explore; unknown human impacts; stewardship; ambassadors of ocean life; physiological adaptations to understand and to add to biomedical knowledge	Basin scale Pacific Ocean; eastern North Pacific Ocean; entire water column	PSATS; electronic tags; acoustics; imaging	9
Hydrates, fluids (seawater and gases); Crustal processes that affect fluid flow	determination of location and volume of hydrate resources; classification; chemistry; fluid flow; subduction zone; hydrothermal processes; microbial populations and dynamics; fluid pressure and quantification of flow	energy source; impact on environment (climate, carbon cycle); geohazard/sea floor stability; means by which earth cools itself; how fluids are forced from crust	300m-3km (maybe more) depths; emphasize below 1000m; EEZ; outcroppings; plate scale; active seeps; middle of plates	acoustic mapping; ROVs; sampling systems; video; sub: long-range AUVs; sensors for gas analysis; sensors for gas analysis; higher resolution chemical sensors	6
How to configure exploration when we don't know form of pay off; what will optimize discovery; issue is larger than NOAA; how to optimize rate of discovery					

Crosscutting Ideas

champion full utilization of underwater arrays
 fuller utilization of classified technologies
 explore ways in which oceanography can be done - cooperate across groups (interagency)

Comments

rare species definition and few in number
 animation of data for science and education
 production of quantitative maps, real time maps
 data management: archival, servicing to public, presorting, relating databases, standard methods for management, cannot be too far removed from scientists
 20% of total effort
 how quickly data is available - measure of success; how much data is coming out
 handling of data sets

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs

"standard" package - definition from common approach terms plus dynamic positioning & bottom high resolution survey capability (not always needed for ops, ROV), sensors dependent upon expertise with mission, high quality communications & internet	"potential" partners - educational outreach group, university (UNOLS), NMS, Navy, NOAA, NASA, NSF, Alliance for Coastal Tech (NOAA), USGS, USCG, NGOs
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Worksheet B: Identify Strategies to Address Priority Exploration Information Needs

Emphasis Area: Ocean Dynamics and Interactions

Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
Knowledge of the deep sea water column (largest biomass on planet)					
1 - simultaneous surveys (AUVs), precision with ROVs	surveys via AUVs; sweeping water column; detailed survey then expand	high; labor intensive for water column	image recognition and software; improving control systems for ROVs - adapt to situations; software development; flow cytometers for microbe levels (refinement in technologies); higher flow sampling for midwater communities	potential	know how ocean works; discovery is guaranteed
Biological oasis hot spots					
1 - targeted (but focused and surveys simultaneously)	close in seamounts then remote seamounts; survey triage of hot spots; different tactics for each hot spot	varies by hot spot	<20 microns technology very important; real time capabilities; anecdotal fisherman reports; tagging (PSATS); "Ready 5" capability	fishing industry (Russians, etc.); MMS	commercial fisheries; potential conservation areas; biogenetics
Habitat on nearshore (shelf and slope); Archaeological paleoclimate area					
1 - targeted	targeted anthropogenic impacts; high definition visual surveys; look for arch. sites of previous civilization; look for deeper wrecks	high (but can vary by hot spot)	sidescan; magnetometers; sub-bottom profiling; laser line scan; range gating system; geochemical measuring systems; geology system (porosity); sediment transport system (suspension)	cultural resource organizations; Navy (NAVO); oil companies; museums; NGOs; National Cultural Archival Org; States Historical Preservation; tribes/islanders; ecotourism	understand part of ocean directly most interact with & human impact; reach new stakeholders; connection to public; conservation areas
Plate scale to mesoscale observatory; long-term understanding of episodic events	small scale perturbative experiments				
1 - funnel; targeted; real time	gyre scale	observatory - may not be low feasibility. Only listed that way due to costs over the long term.	large logistics; huge communications requirements	telecommunication industry; oil/gas industry; Canada, Germany, etc.	internationally unique; new paradigm of sampling in time and space
Canyon systems, gulleys (physical, chemical, biology systems)					
1 - targeted; observation	hyperpicnal flows; observing systems for long term; investigate submarine rock flows	mod (difficult to catch events)	forward scatter acoustic techniques; equipment survivability cabling systems; need hardened sensors; "instrumented rock"	cable companies; USACE; CSO	understand how major component of the ocean works; history/origin of canyons
Productivity of ocean in euphotic zone	understanding life stages of organisms				

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Emphasis Area: Ocean Dynamics and Interactions					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
1 - funnel; survey		high	new genetic methods; new techniques for energy flow thru life form systems; genetic probes; active fluorescence	Russia, Poland; agriculture companies; commercial fisheries; remote sensing (NASA)	understanding health of oceans
Knowledge of the deep sea floor					
1 - simultaneous surveys (AUVs), precision with ROVs	surveys via AUVs; sweeping water column; detailed survey then expand	high; labor intensive	image recognition and software; improving control systems for ROVs - adapt to situations; software development; flow cytometers for microbe levels (refinement in technologies); higher flow sampling for midwater communities; navigation	potential	know how ocean works; discovery is guaranteed
Pelagic animal movement and orientation	how animals find guideposts in the open ocean; animals as ocean explorers	large animals - high; medium animals - mod; smal animals - developing	PSATS, archival tags, acoustic network tracking; active acoustic tracking; ARGOS; imaging systems	university; electronics industry; Census of Marine Life; fishermen (recreational & commercial); conservation groups	establish biological hotspots in ocean; identify common mechanisms of movement; conservation and protection of important species

Comments:

need more tech capable organization and facilities

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Observation and Mapping					
Information Need/Gap	What	Why	Where	Technologies	Interest
Continental Shelf	general baseline mapping (high resolution), habitat substrate, geo/bio/chem, current, temperature, ID and characterize	Need good habitat mapping, documenting relationships between bio and surrounding habitat. Near shore is important commercially and recreationally. Need to identify impacts to these areas.	West Coast, existing protected areas, proposed MPAs, cable routes, heavily trawled areas, areas of heavy coastal/urban development. Same locations as above. Also untouched areas.	Standard regular remote sampling techniques, temporal/seasonal sampling tools. Higher resolution remote sampling; processing/visualization tools	1
Midwater	Species diversity; ID and characterize; food web; link between upper water and benthic water; how the midwater functions in this role; evolutionary relationships; geographic relationships; connectivity	Not much known, relation with upper water community	Gross global sampling (have some info on Japan and Monterey Bay)	Genetic tools; ROVs for filming, sampling and observing behavior; HDTV video very useful; establishing strobe frame photography at some time series sites to get understanding of change of abundance	2
Banks	mapping, subsurface information, sub bottom profiling, biosampling, currents, temperature, chemical description, cores to sample the microbial activity	Untouched communities to understand equilibrium before disruption; trying to understand how they evolved thru time (e.g. transient?, duration of settlement in any one spot.) Unique species w/ biochemical properties; Assessing connectedness among and between; Genetic fingerprinting of some of the species; Effects of exploitation	Cordell Banks, Tanner/Cortez Bank, Oregon Bank complex, Southern California Border Banks	Chemical sniffers, NMR, genetic fingerprinting, acoustic mapping, long term chemical sampling (e.g. osmosamplers)	3
Sea Mounts	mapping, subsurface information, subbottom profiling, biosampling, currents, temperature, chemical description, cores to sample the microbial activity	Untouched communities to understand equilibrium before disruption; trying to understand how they evolved thru time (e.g. transient?, duration of settlement in any one spot.) Unique species w/ biochemical properties; Assessing connectedness among and between; Genetic fingerprinting of some of the species; Effects of exploitation	Davidson, Guide, and Pioneer Seamounts, and Gumdruk and Taney Seamounts; Brown Bear and Cobb Seamounts; Bowie Seamount Chain.	Chemical sniffers, NMR, genetic fingerprinting, acoustic mapping, long term chemical sampling (e.g. osmosamplers)	3
Canyons	mapping, subsurface information, subbottom profiling, biosampling, currents, temperature, chemical description, cores to sample the microbial activity	Untouched communities to understand equilibrium before disruption; trying to understand how they evolved thru time (e.g. transient?, duration of settlement in any one spot.) Unique species w/ biochemical properties; Assessing connectedness among and between; Genetic fingerprinting of some of the species; Effects of exploitation	Canyons: Big Sur Canyon Complex, Pt Conception complex; Juan de Fuca; Rogue Canyon, Eel River Canyon; Quinalt Canyon; Santa Cruz Canyon; So American canyons (re: strike slip transition).	Chemical sniffers, NMR, genetic fingerprinting, acoustic mapping, long term chemical sampling (e.g. osmosamplers)	3
Fracture Zones	mapping, subsurface information, subbottom profiling, biosampling, currents, temperature, chemical description, cores to sample the microbial activity	Untouched communities to understand equilibrium before disruption; trying to understand how they evolved thru time (e.g. transient?, duration of settlement in any one spot.) Unique species w/ biochemical properties; Assessing connectedness among and between; Genetic fingerprinting of some of the species; Effects of exploitation	Mendocino, Molokai.	Chemical sniffers, NMR, genetic fingerprinting, acoustic mapping, long term chemical sampling (e.g. osmosamplers)	3

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Observation and Mapping					
Information Need/Gap	What	Why	Where	Technologies	Interest
Subduction Zones	mapping, subsurface information, subbottom profiling, biosampling, currents, temperature, chemical description, cores to sample the microbial activity	Untouched communities to understand equilibrium before disruption; trying to understand how they evolved thru time (e.g. transient?, duration of settlement in any one spot.) Unique species w/ biochemical properties; Assessing connectedness among and between; Genetic fingerprinting of some of the species; Effects of exploitation		Chemical sniffers, NMR, genetic fingerprinting, acoustic mapping, long term chemical sampling (e.g. osmosamplers)	3
Deepwater corals	Locate, map, characterize and ID; Assessment of threats - existing and emerging. Other species supported by habitat.	Extremely cool, very old, contain excellent deep sea climate records (deep sea climate gradients), loaded with bioactive chemicals, biomedical applications, very diverse and economically important, at dire risk of elimination.	Rocky bottom areas; low sedimentation rates, high currents - below trawl depth. 1-2 KM priority. Monterey Canyon, Astoria Canyon Flanks of seamounts (see above).	Deep camera tows, further development of laser technology, lowlight cameras in rough terrain, slow moving steady AUVs	3
Ships (shipwreck) of importance.	mapping habitat, multidisciplinary effort, chemo/bio/geo	Environmental impact, maritime history, exciting topic, legal/regulatory mandates	Workshop results and historical records. Determine location. Luckenbach (San Francisco), Montebello (off Cambria) possible tar issue, Pack Baronesc (entrance of Santa Barbara Channel) bulk cargo of copper sulfate.	Mapping technology, chemical analysis, shipwreck integrity tools	4
Marine Archaeology/ Human Habitat	Develop strategy on where to look, location, photo documentation, controlled removal, habitat, climate	Would answer major questions about inhabitants of west coast of North America, would answer timing questions, Heritage Data	Develop strategy on where to look; Channel Islands, 140 m below sea level (old coastal level), Santa Barbara Channel, Baja California	Mapping of shorelines, light subbottom profiling, laser linescan technologies to direct sampling, coring technologies	4
Use of pelagic and benthic environments by economically/ecologically important species	Life history, migration patterns, habitat, population, distribution and abundance, environmental properties	Ecologically and economically important; exploited; need to know how they use their environment in order to get accurate assessment of them and to protect them if need be.		Basin wide, continental shelf, oceanic, existing protected areas, also see offshore productivity list, fronts and eddies	5
Use of pelagic and benthic environments by Rare Species	Life history, migration patterns, habitat, distribution and abundance, population, environmental properties	Little known about them, sense of urgency, they engender energy and excitement from public,	Same as above	Satellite tag, data storage tags, satellite remote sensing (benthic and passive), acoustics (passive and active), genetic tools, aircraft, human observation	6
Microinvertebrate assessments e.g. kelp forest assemblages and soft habitat; microbial ocean	Assemblages; Interactions; Predator/Prey Relationship	Huge educational advantages; Community structure and function; Form base of food assemblages; Unknown; New Species	California kelp forests, soft benthic habitats out to 60' (20-60' water depth)	Fiber optics, cameras, video, basic archaeological sampling, species identification	7
Microbial	Microbial assemblages, characterization, taxonomy, role they're playing in larger ecology; bio/geo/chemical processes; bioactive compounds	Biotechnology; human health; (e.g. blooms); cause-effect; pollutants (tracking)	Could go anywhere and make fundamental discoveries i.e. polar oceans, polluted and non polluted locations to compare microbial assemblages; Throughout water column including the substrate	In situ genetic sampling;	8
Seeps	mapping, subsurface information, subbottom profiling, biosampling, currents, temperature, chemical description, cores to sample the microbial activity	Untouched communities to understand equilibrium before disruption; trying to understand how they evolved thru time (e.g. transient?, duration of settlement in any one spot.) Unique species w/ biochemical properties; Assessing connectedness among and between; Genetic fingerprinting of some of the species; Effects of exploitation	between Heceta Bank and Hydrate Ridge; along alluvial (sp?) washout of Monterey Canyon.	Chemical sniffers, NMR, genetic fingerprinting, acoustic mapping, long term chemical sampling (e.g. osmosamplers)	9

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Observation and Mapping					
Information Need/Gap	What	Why	Where	Technologies	Interest
High Temperature Hydrothermal Environments	Relatedness	Important for understanding origins of life on Earth	West coast of North and South America (fragments of the Farallon Plate) - interaction of a ridge with a continental margin), opportunity to look thru genetic mutations, how long ago were things isolated?	ROV sampling tools; physical oceanographic sensors; Larval sampling tools	9
Chemistry, Physics, Geology	Biogeographic cycling; inputs/outputs cycling	Residence times of certain molecules and chemicals; ID sources/sinks; understand effects of human introduced substances; better resource management;; better understanding of time based on signature left by processes; understand processes on other planets	Needs to be done in the context of the other Needs identified	In situ chemical sensors; satellite data; remote sensing;	Integrate
NOTE: Chemistry, Physics, Geology need should be integrated as part each need	NOTE: OE should analyze globally where seeps form (before shipping out)			NOTE: need new technology (and cost effective tools) for covering (to survey) large areas for energy sources and need technology that goes deep, especially unmanned technology - below photic zone.	
Technology Needs	Better data visualization tools; Registry of available data; Technology that supports adaptive (event driven) sampling				
NOTE: use part of 10% slated for education for visualization tool development. Info is only useful if it can be delivered.	NOTE: Ferret out traditional knowledge as way to discover what may have already been seen	NOTE: Reenact historical expeditions for educational purposes	NOTE: Reenact historical expeditions for educational purposes	NOTE: Jacques Cousteau Formula	
NOTE: more system examination of marine taxonomy through genetics	NOTE: Other data sets that can contribute to these needs				

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs	
Emphasis Area: Observation and Mapping	
Standard Package - add CTDs to original list	Standard Partners - NSF, NURP, ONMS, NMFS, Fish & Game, Oceanographic Institutions, Universities, Private Foundations, Museum/Aquaria, Sea Grant, Private Industry, Navy, USGS, NASA, MMS, Intl Partners, state geological survey, SHPO, Canadian counterparts, Mexican counterparts,

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
Continental Shelf			Standard Package - ROV, Sub, multibeam, bioacoustics tech, ADCP, seismic profiling, remote sensing, observatory approach	Std Partners-states, sanctuaries, NOS, NOAA hydrographic program	Scientific: delineation of habitats, base mapping, basic understanding of benthos, substrate characterization Industry: mineral deposits, new resources, resource evaluation, biotech Outreach: "backyard", educational component (student & public), visualization benefits, involve public, entire community Conservation: sustainability, rational decision, biggest info gap
Funnel	Benthic				
Targeted	MPAs, proposed MPAs, cables, then go observe				
Productive Offshore Areas					
Funnel	Survey-go down and explore	High	Std Package - larger vessels, backscatter data, observatory tech (observation approach), chemical sniffers, NMR, collecting tech, genetics, real-time processing, time-series revisits	STD Partners, no states,	Scientific: same as continental shelf, processes and interactions among organisms Industry: better resource planning Outreach: open new world, great discovery opportunities Conservation: planning, resource management, untouched environment, defacto protected areas
Targeted	Use existing data to make choices then survey and go down	High			
Observation	Time series observation (many instruments), time lapse camera to observe biota over time	Medium			
Partner w/ existing assets (opportunistic), Teaming	"piggyback" off existing assets and vessel	High			
Midwater Mobile Observation	AUVs/ROVs to remotely survey then sampling	High	STD Package - suction samplers, insulated compartment, observation & tracking technology, large samplers (new tech), collection tech, AUVs that follow, critters (new tech)	STD Partners - HBOI, Canadian ROPOS, MBARI, JAMSTEC (Japan), National Geographic Society, Discovery, MBA, aquaria	Scientific: important to carbon cycle, lots of species unknown to science, unknown contribution to food web Industry: app of new tech Outreach: topic of interest for general public, huge gee whiz factor, same as before Conservation: dumping regs
Moored Observation	Fixed position observation	Medium			
Tracking	Tag and Monitor, lifecycle	Medium			
Critter Cam	Place camera on critter	High			

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
Marine Archaeology			High Res Imaging, Side-Scan, STD Package, Magnetometer, removal technology tools, laser imaging, saturation diving	Insurance industry, EPA, Coast Guard, ONMS, DOS, DOD, states, National Geographic, Discovery, Salvage Industry, (Ole Varmer - NOAA NOS Shipwreck Attorney)	Scientific: heritage insight, impact on environment & risk assessment, human occupation of NA Industry: salvage Outreach: tremendous potential Conservation: mandate to ID, protect and preserve
Targeted	Historical records/archives, traditional knowledge, pick sites, document & remove	High			
Funnel	Map (paleo shoreline), pick sites, doc & remove	Low			
Opportunistic	Look at mapping info from other missions then go to sites	Med-High			
Microbial Biology			Moorings, AUVs, sampling tools, smaller vessels, genomics, ROVs & HOVs, chemical analysis tools	Biomedical industry, EPA, Fish and Game, local and state health depts, Surfriders	Scientific: huge oppty for fundamental discovery, bioactive compounds, health in the coastal zone Industry: seafood, biotech, invasive species, human health, biotoxins Outreach: origin of life, challenge for outreach, conceptual more than visual Conservation: counteracting bioterrorism
In situ Sampling	In situ sampling and genomic identification & chem	High			
In situ Cytometry	Particle counter for small particles - size fractions	Med-High			
Bioluminescence	cameras - is there a good proportionality ratio that is pretty universal.	High			
Pelagic & Benthic	Ecologically/economically species		CODAR, STD Package, Tag tech Critter cam, acoustic processing tech, LIDAR	STD Partners, NPS, Military, biogeochemistry academic community, intl partners, Stanford Hopkins Marine Station, Census for Marine Life, MLML, Packard Foundation	Scientific: basic knowledge of behavior, migrations and how they use their environment, resource management Industry: sport fishing, small business Conservation: need to know more to protect them
Data Storage Tags	Track location of critter	High-Med			
Acoustic Tags	Beacon to uniquely ID individual	High			
Critter Cam	Attach critter cam	High			
Targeted	fronts/eddies - use remote sensing to ID areas	High			
Passive Acoustics	Listen and observe sounds	Medium			
Airborne Sensing	LIDAR to monitor, observe, track fish	Medium			
Natural Tags	Otolith-microstructure/microchem to ID their source/to track them/ageing	Med-High			

North Atlantic Workshop

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Information Need/Gap	What	Why	Where	Technologies	Interest
Understand Distribution & Functional Redundancy Between Communities of Organisms	Stems, communities	Not currently known, new biota, are there common rules governing these communities. To be able to develop first principals on how communities are constructed. In order to advise decision makers in areas where there is little data. Automatic education tool.	Canyons, slopes, cold seeps, seamounts, the abyss, fishing banks, oil seeps, hot vents, cold seeps, and on continental shelf - banks and basins. Canyons along NE and West Coast. NE Seamounts and West Coast seamounts; South America.	Standard set of methods - (see Technologies list above)	1
Areas of Abrupt Bottom Topography.	Abundance, diversity, community change, new species, turnover, refuge community, patterns	Tight coupling to water column, high flow, high productivity in benthic and epibenthic communities, fish communities, rapid community change in terms of abundance and diversity.	Seamounts (any seamount within our region e.g. Bear, Physalia, Mytilus, Picket); any offshore ledge, canyon heads e.g. Oceanographer, Hydrographer, Veatch, Norfolk, Baltimore; northern edge of Georges, in coastal zone where there is a steep channel among islands; gullies; ledges e.g. Gulf of Maine ledges, Stellwagen Bank, Jeffreys Ledge, Cashes Ledge	Refine the mapping, multibeam, AUVs in high flow situations, SCUBA, standard tools	1
Living Marine Resources	ID & characterize patterns	Commercial activities expanding into this region and we have little knowledge about these areas	Unexploited areas, unsurveyed areas, slope greater than 500 m, seamounts (see above), Mid-Atlantic Ridge	Standard technology	1
Exploring Species Interactions w/ Physical Environment	Physical, biological, ecological properties that govern these locations, patterns	Better understanding of communities for management purposes	Similar to "Understanding Distribution" need and "Areas of Abrupt Bottom Topo" need; also Fronts and gyres, and warm core rings	Standard Tools	1
Study Transitional Areas Between Biogeographic Areas & Shelf Slope Regions	Species distribution and ranges; species dynamics, tropic interaction, invasives, patterns	Very little information available that is not broad scaled; what regulates them?	Georges Bank, Cape Hatteras, 350m isobath, any biogeographic breaks	Standard Tools	1
Ecosystem Engineers and foundation species (corals, tile fish)	Abundance, location, diversity, new species, establish patterns	Ecologically important, management conservation issues, few species have effects on many	For corals: shelf break, canyons, edges of basins, seamounts, deep and inaccessible; For Mussels: Grand Manan Basin, upper slope environment	Standard plus time series observations	1
Bioprospecting	Biotech industry	New products from the sea, human health, industrial processes, quality of life	Areas of high diversity, abrupt topo changes, deep within our region and tropical,	Bioprospecting technology, standard sampling technology that capture and keep specimen alive	1
Novel Feeding Relationships		Unknown and could be major sources of nutrition; discover new linkages	Coastal regions near algal beds, offshore basins, depositional environment, marine mammal hotspots	Sampling & stable isotope analyses for food pathways; remote sensors for marine mammals; Critter Cam	1
Shipwrecks (5-10K off New England)	Location, ID & characterize	We know little about historical technology; education and public relations, human history	Close to shore: fishing banks (Georges Banks, Jeffreys Ledge, Gulf of Maine, shipping lanes - close to shore, "right down the list"	Magnetometer, archival technologies, AUVs	2
Submerged Prehistoric Sites	Location, ID & characterize, which are still intact, paleogeography, paleo communities, paleo biological assemblages	Same as above	Shallower than 120m isobaths, near major drainages, coastal embayment, areas of intense fishing activity	Geologic mapping, coring, sub-bottom profiling, side-scan, magnetometer, AUV, Also local knowledge	2
Pelagic Realm - surface to deep sea	What's there? Species diversity issues, location, ID and characterize, function, what's there to exploit & conserve, patterns	Don't know what's there	Beyond shelf break e.g. Oceanographer Canyon and south	Submersibles, ROVs, acoustics, sampling tools to collect gelatinous organisms	3
Observing Episodic Events & Rare Species e.g. storm, blooms	Short-term events - frequency, strength, intensity, impact, magnitude, compare & contrast	Non commercial activity, not done, understand processes, synergy	MPAs, abrupt bottom topography, areas representative of a range of topographies e.g. ledge vs. flat bottom; e.g. Gulf of Maine, marine mammal habitat,	Camera, observation technology	4
Observing Rare Species	For fish & marine mammals: migratory & threatened species e.g. location of bottleneck dolphins, unusual spawning, general behavior	Fish community diversity, species extinction, sentinels of change, invasion, insight into species dispersal,	MPAs, fish aggregation areas e.g. Stellwagen Bank, ledges, fishing grounds, plane used by marine animals	Cameras, observation technology	4
Non Biological Resources (note: this should not be the focus of OE)	Minerals, oil & gas, hydrates, location, occurrence, stability, mixed aggregate	Valuable resources, data sharing, (sources of info)	U.S. EEZ	Archive data	5

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Information Need/Gap	What	Why	Where	Technologies	Interest
Seamounts	Systematic documentation	Not well documented	All seamounts e.g. New England seamount chain	Standard	6
Submarine Canyons	Not well documented	Not well documented	All major canyons e.g. Georges Bank canyons and mid-Atlantic canyons e.g. Oceanographer, Veatch, Baltimore, Norfolk, and Wilmington Canyons; Pueblo village communities and the canyon axis, boulder fields, slip stone outcrops	Standard	6
Ledges	Not well documented	Not well documented	Jeffries Ledge, southern Cashes Ledge, Fippennies, Platts, all along the coast of Maine e.g. smaller coastal ledges	Standard	6
Banks	Not well documented	Not well documented	Stellwagen & Georges Bank, Nantucket Shoals, Tillies & Browns Banks, Banquero & Emerald Banks	Standard	6
Basins	Not well documented	Not well documented	East & west Tillies Basin, Georges, Jordan, Wilkinson & Stellwagen Basins	Standard	6
Abyssal Plain	Not well documented	Not well documented	South of Oceanographer & east of Norfolk Canyon	Standard	6
Slopes (600 to 4000 ft)	As above	As above	Slopes adjacent to ID canyons or seamounts	Std	6
Gravel Windows - sediment disturbed & gravel exposed	As above	As above	Stellwagen Basin	Std	6
Protected Paleo Shorelines	As above	As above	South of Long Island & Nantucket; Gulf of Maine, Weymouth	Std	6
Gravel Cobble Bottom - continuous features vs discrete	As above	As above	Corsair, Oceanographer, & Hydrographer Canyons, Stellwagen & Georges Bank, Great South Channel, Jeffreys Ledge	Std	6
Channels	As above	As above	Great South Channel, Northern Channel	Std	6
Glacial Scoured Areas	As above	As above	Northeast Stellwagen Bank, Jordan Basin	Std	6
Shipwreck Aggregation Sites	As above	As above	Nantucket Shoals, Hatteras, Graveyard of Atlantic, Stellwagen Bank, Boston Harbor entrance, Long Island Sound, Buzzards Bay, Narragansett Bay, entrance to Chesapeake Bay, outer Cape Cod, Casco Bay, & New York Harbor	Std	6
<p>Issue: How do we get access to existing data specifically for submerged archaeological sites? John Fish, American Underwater Search and Survey, most extensive submerged arch site data. Need to work with them e.g. data coordinator to look across exploration data to see how it would be useful to others.</p> <p>Issue: when do you not let the public know about submerged archaeological sites?</p> <p>Issue: Use charts to ID blank areas that have been unexplored.</p> <p>Issues: Seafloor topography - mapping should be derivative of exploration rather than the focus; work with other NOAA offices; multi-beam area for multiple exploration efforts</p> <p>Issue: Storing of data</p> <p>Issue: Resource mapping should be in public domain</p> <p>Notes: #6 should be discussed in the context of these other information needs.</p>					

Worksheet B: Identify Approaches to Address Priority Exploration Information Needs

Deep "Standard" Package (1): Class I/II Vessel with Acoustic Mapping; Dive Capability (ROV/AUV/Submersible) with Imagery/Video and Sampling Equipment; Precise Positioning System; Nav Mapping Tech; Coastal Standard Package (2): Class III/IV Vessel; Wet Diving Chamber/Compressor; DMT; Dive Master; Acoustic Mapping; Side Scan; Precise Positioning System; Nav Mapping Tech

"Standard" Partners

Worksheet B: Identify Approaches to Address Priority Exploration Information Needs

Information Need - Approaches	Description	Risk	Enabling Technologies	Partners / Available Assets	Key Benefits
Ecological/Biological Group (1)					
Transect Approach	Large Group Set Sampling Standards (includes ability to document serendipitous), look in new places, choose sites based on biogeo (lat & between oceans), survey along mega transects, multi-beam maps, sampling all along transect	Low	Coastal & deep packages, near real time satellite imagery, coring, suction sampling, digital still & digital/HD video, laser scaling, stereoscopic video, new applications of existing technologies, sidescan or sector scan sonar, dredge & trawl, laser line scan	Std partners, academia, NMFS, NURC, WHOI, DOI, Kokes, Navy, industry e.g. biotech	Scientific: pattern & distribution of tax & biological diversity; biogeography Industry: new resources, biotech products Outreach: mega big bang vs. targeted; web; circulation development Regulatory: new species; conservation targets; new MPAs
Targeted	Feature based approach; sample at selected sites	Low	Near real time satellite imagery		
Time Series Observations	Seasonal based observation transects, obs station taking temporal readings	Low	Obs tech that observe bio prop in addition to other ocean prop, cameras to monitor species, near real time satellite imagery, std oceanographic sensors, recruitment collectors, acoustics (passive & active), digital imagery, AUVs w/ sonar, ADCP		
Survey	Broad based remote sensing to select site; then same as others	Low	Satellites, Coastal & deep packages, near real time satellite imagery, coring, suction sampling, digital still & digital/HD video, laser scaling, stereoscopic video, new applications of existing technologies, sidescan or sector scan sonar, dredge & trawl, laser line scan		
Submerged Archaeological Sites (2)					
Funnel	Broad based surveying; choose sites; remote sensing, dive/ROV, sampling	Med	Coring; trenching; sampling tech; coastal std pkg or deep depending upon location; magnetometer; important to have; nav technology; sidescan and sector scan sonar, subbottom profilers, AUVs/ROVs, SCUBA/mixed gas, laser scan, digital mosaics, 3D imaging w/ sonar	Academia; Naval Historical Center; ONR; SHPO; Museums, ACOE; MMS; commercial survey companies (OSI & Alpine); ONMS; NURP; AUSS (John Fish); IFE; commercial contract archaeology companies; USGS; JASON Foundation; National Geographic Society	Scientific: location of significant sites; distribution models Industry: cleared areas for cables; pipelines; dredging; fishing; museum collections Outreach: significant public interest; educational possibilities Regulatory: federal/state agency mandates; MPAs
Targeted	Use existing knowledge including data mining (examine multibeam data), obs w/ remote sensing, dive/ROV, sampling; fishermen (hang sites)	Low			
Piggybacking	Tagging along w/ existing expeditions, same as above, impt to have archaeologists on board	Depends on location (possibly M)			
Pelagic Realm					

Worksheet B: Identify Approaches to Address Priority Exploration Information Needs					
Information Need - Approaches	Description	Risk	Enabling Technologies	Partners / Available Assets	Key Benefits
Use all #1 approaches			Std Pkg, sampling gelatinous orgs, these tools on ocean platforms so they are full ocean accessible, sfc obs techs (incl night vision approaches), CTD, ADCP, profilers (water column-AVPPPO), in-situ chem sensors	MBARI; HBOI (biolum)	Same as #1 Scientific: behavior patterns (critter) Industry: biotech Outreach: video of critter cam & gelatinous orgs Regulatory: MMPA, highly migratory species
Bioluminescence	Use biolum to determine distrib & abundance of different species	Low			
Critter Cam (small # of animals)	Use of camera on species	Med			
Tracking	Tracking organisms	Low	Acoustic telemetry, air interface tech		

Issues:

Count stars & compare groups

Infrastructure for data collection & distribution

#4 = Research

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Information Need/Gap	What	Why	Where	Technologies	Interest
Knowledge of Near Shore environments	Inventory, characterize Measure, habitats, bathymetry, Bio/Geo/Chem, Archeology	Most regulation oversight	Coastal New England	Shallow water mapping, Sediments, Remote Sensing, in Turbid water	13
Regional Archaeological Assessment; Cultural Resources, Chronology Site I.D.	Distribution of Wrecks; Structures; Aircraft, Items of cultural impact, Dump sites Identify all cultural resources with in a region.	Many sites are not identified; Environmental impacts; Human activity on the world; Chronology: Prehistoric, Historic, Current	Regional Assessment Sampling strategy needed (sites with a range of maritime landscapes; Regulation	High Resolution Survey - SUBS/ROVs /AUV's; magnetic Acoustic sensors	13
Knowledge of Gas Hydrates Provinces	Process of Gas Hydrates potential resources Effects of gases on chemosynthetic communities, Climate Impacts, Slope Quality	Impact on Global Climate; Impact on Habitats; Safety - Tsunami, bottom mounted cables	US EEZ; Hudson Canyon Region, (fiber Optic Hub)	Submersibles ROV's Sampling Methods	12
Need for increase expertise in Taxonomy of marine resources	National emphasis on taxonomy; Career field	Identify Interaction between Taxonomy	No specific regional focus	Technology can enable but its policy based - Human resources; presentation formats	12
Knowledge of impact of Seamounts on ocean dynamics; Also other abrupt topography	Ocean Currents, Ecosystems, Biogeography, Biodiversity	Impact on Fisheries health, Fundamental dynamics needed, role as biogeographic "stepping stones" Record of climate change in deep Corals	Bear Mount, New England Seamount chain; Mid Atlantic Ridge; Cashes Ledge; other small features	Sub/ ROV's/ AUV's Video Imagery, Sampling Systems; Acoustic Mapping	11
Character of Deep Water Archaeological sites	Wrecks; structures; cultural resources; Priority to older targets; local biota	Public Interest; Education; Historic Value; Regulation; Relationships to Habitats; Ecological Impacts;	Target identified by broader area of survey - Virginia Capes;	Deep water sub's ROV's / AUV's / Imagery & Video; remote manipulator; magnetic	9
Distribution of migration & abundance of Large, highly mobile biota	Marine Mammals; Giant Squid, Other Unknown species, Large Deep water Sharks;	Lack of Current knowledge, Public Interest, understand biodiversity & role in Ecosystem; Policy (International & Domestic)	Beyond Continental margin	Survey Technique; Tagging & Tracking; Acoustic Imaging, AUV's Imaging	9
Deep Pelagic Realm	Characterize, Biology Dynamics	Largest Ecosystem, Not sampled much	Sea Mount & Canyons Along the Continental shelf Greater 1000 meter & meso	Deep Submersibles, obs on a broader scale, AUV's; Acoustics Imaging, chem, Bio Sensor	7
Knowledge of Deep Benthic Community	Characterize, Biology, Geology, Bottom Interactions, Ecology Dynamics	Need to ascertain anthropogenic impacts; not well known,	Topographic feature of interest	Deep Submersibles, obs, AUV's; Acoustics Imaging, chem Sampling Techniques	7
Knowledge of existing sources of Baseline knowledge	Data Mining	Establishes level of baseline knowledge	All	Data Mining technology; Intelligent Agents	7
Knowledge of Submarine Canyons	Transport mechanism, Habitat Diversity, Sediment Transport; nutrient transport	Fisheries Impacts; Characterize Pollution Impacts, Impact on habitats Role of in Carbon cycling; Terrestrial impacts	Continental Margin; Hudson Canyon; Lydonia Canyon; Varied Geomorphology; Gradient of Human influence	Sub/ ROV's/ AUV's Video Imagery, Sampling Systems; Acoustic Mapping	6
Knowledge of physical & biological processes near fronts; Eddies, Warm and cold rings	Intersections between layers; Relationships to biota; Air-Sea Patterns / Interactions Impact of bottom boundary	Science Value; Impact on Fisheries; Lack of knowledge on Nutrient Sediments Transport; Impact on Cultural Resources & benthos	Gulf Stream; Labrador; Gulf of Maine; Long Island Sound	Remote Sensing; Fixed Sensors; Sensor Arrays; AUV's	5
Distribution migration & abundance of Gelatinous plankton	Pelagic Plankton, Vertical migration patterns	New Species Identification, It is the dominant Biomass; Fisheries Impact, Evolution Knowledge	Seamounts; Canyons; Along Shelf margin	Sampling Technology, AUV's	5
Knowledge of Deep and or Cold water Corals	Biodiversity, Distribution habitat	Fisheries Impacts; New species identification; Role in Ecosystems; Possible records of climate changes	Bear Seamount, Oceanographer Canyon, Lydonia Canyon, Nova Scotia & New Brunswick	Sub/ ROV's/ AUV's Video Imagery, Sampling Systems; Acoustic Mapping	4
Knowledge of Physical Processes related to geomorphology	Mass-gravity movement; Turbidity flows; Hydrate beds; slope instability; chemical analysis	Understand canyon formation processes, safety (geo-hazards) habitats, (*Partner with USGS)	US Continental Margin, Hudson Canyon region,	Sub/ROV/AUV Imagery, Seismic Survey; MCS; Acoustic Mapping	4

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Information Need/Gap	What	Why	Where	Technologies	Interest
Knowledge of impact of Fishing on Ocean Regions	Health of Benthic Habitat; Census of Marine Life; Archeological Impacts; History of technology;	Regulation; Public Interest; Impact on other Ecosystems; Fisheries Management; Lack of Info on Deep Benthic Fish; Discover the role in habitat information	Grand Banks, Georges Bank; Gulf of Maine; Area where fisheries are expanding into;	Sub/ ROV's/ AUV's Video Imagery, Sampling Systems; Acoustic Mapping	3
Chemosynthetic communities (subsurface - down several km): hydrate vents, seeps and vent communities	inventory and characterize, isolated ridge system, new biota, larger geographic context, physical & chemical systems	unknown regions, new biota, explore why communities exist, what turns these areas on and off? Significant communities through evolutionary genetics links between regions	Mid-Atlantic Ridge	multi-beam geophysical techniques, sampling techniques, satellite imaging, towed vehicles, subs, AUV's look at new technologies	2
Knowledge of micro-organisms in the deep sub-bottom	Sea floor Biosphere	Discover new life in sustaining process, biodiversity, science benefits, Exobiology interest, Origin of Life - Evolution Role	Deep water	Deep sampling technology: Ocean Drilling Program,	1

Worksheet B: Identify Approaches to Address Priority Exploration Information Needs

Standard Package: Class I/II Vessel w/Acoustic Mapping; Dive Capability (ROV / AUV / Submersible) w/ Imagery / Video & Sampling Equipment (Not Only ROV / AUV / Sub); Multibeam; ADCP's; Precise Position System; Outreach Capability; Education Component

Standard Partners: Sea Grant; IFE; NMFS; NOS; NURP; UNOLS

Worksheet B: Identify Approaches to Address Priority Exploration Information Needs			Enabling	Partners /	
Information Need - Approaches	Description	Feasibility	Technologies	Available Assets	Key Benefits
Knowledge of Near Shore Environments	Characterization			USA Core of Engineers	
Regional Archeological Assessments	Bio / Geo / Chem			State GOVT's; Academia; Aquariums; Not For Profit Entities; Science Education; USCG; Navy; Commerical	Science: Knowledge of nearshore environment Outreach: Large Public Interest & Impact
Physical / Biological shallow water processes Near Fronts					
Cold Corals					
1. Shallow Water - Small vessels	"Funnel" Approach	High	Archeological Application; Magnetic Sensors	Sea Grant Program	Regulatory: State & Local Governments; Recreational / Sport Fisheries; Commerical Fisheries
	"Funnel" Approach	Moderate	Bottom mapping & tion capability; New otocols; Multi Line Multi Sensor Arrays	Aquariums (Maritime Aquarium @ Norwalk; Mystic, National Baltimore New England)	Regulatory: State & Local Governments; Recreational / Sport Fisheries; Commerical Fisheries; Education: Bio-Technologies, Bio-Products
2. Autonomous Vehicles	"Funnel" Approach	Moderate	New sampling protocols; Multi Line Arrays and Multi Sensor Arrays	Maritime History Museums (Mystic Seaport)	Invasive Species; Cultural Resources; Resource Management
3. Aircraft	"Funnel" Approach	Low	- LIDAR(?)	Natural History Museums (Cape Cod)	
4. Field Sensors & Sensor Arrays	"Observation" Approach	Moderate	Chem / Bio / Geo Sensor Development	National Estuarine Research Reserve (Rachael Carson, Jacques Cousteau)	
				Smithsonian	
				Informal science education entities (Project O, Chesapeake Bay Foundation)	
Phys / Bio Process				States Aquariums; Educational Institutions; Non-Profits; Commercial Ventures	
Near Fronts Eddys					
Cold & Warm Rings					
Regional Archeological Assessments					
Deep Cold Corals			Data Mining, Conservation Technologies		
1. "Standard Package"	"Funnel" Approach	High	Magnetic Sensors; Sub-Bottom Profilers; Chemical Sensors; "Tailored" AUV Designed for Archeological Assessment		<u>Regulatory:</u> Conservation, Fisheries, Policy Development <u>Outreach:</u> Public Interest, Historical Perspective, Education, <u>Science:</u> Habitat Assessment, Biodiversity, Bio-Technologies, Bio-Products <u>Industries:</u> Commercialization, Tourism, Understanding of Distribution
2. Fixed Sensors, Sensor Arrays & Mobile Sensors	"Observation" Approach	Moderate			
3. Space-Base Remote Sensing	"Targeted" Approach	High / Low	Penetration into Deeper Water		
Knowledge of Gas Hydrate Provinces				Universities	<u>Science:</u> Habitat Assessment, Ecosystems; Climate Change Indicators

Worksheet B: Identify Approaches to Address Priority Exploration Information Needs			Enabling	Partners /	
Information Need - Approaches	Description	Feasibility	Technologies	Available Assets	Key Benefits
Knowledge of Impact of Seamounts & Abrupt Topography on Ocean Dynamics				Navy, Aquariums;	
Character of Deep Water Archeological Sites				Non-Profits; Museums	<u>Industry</u> : Potential Commercialization, Tourisms, Salvagers
Distribution of Large Highly Mobile Biota				States, DARPA, NSF, ASTO, DOE	
Submarine Canyons					<u>Regulatory</u> : Area Management, Species Protection Species, Salvage Policies
1. "Standard" Package	"Funnel" Approach	High	Non-Destructive Investigations, Robotic Manipulation; Sub-Bottom Profiling, Tools for Sample & Artifact Recovery, Interpretation Tools, Spectral Analysis Tools; Data Mining; Laser Line Scan, Critter Cams		<u>Outreach</u> : Education, Public Interest
2. Fixed Sensors, Sensor Arrays & Mobile Sensors	"Obseration" Approach	Moderate	Remote Tracking (Aircraft or Space-Based)		
Expertise in Taxonomy of Marine Resources	-Education		National & International Standards; Collections Management; Scholarship Programs	Educational Institutions; Sea Grant (?); Museums; Non-Profits	Critical to Establishing the Baseline of Existing Knowledge
	-Career Field		Training in Fieldwork for Applicable Disciplines		
	- Available Pool of Experts		Sponsoring Existing Entities with Expertise		
			Expert system can help enable		
			Graduate Fellowship Programs		
			Establish Positions (FTE's) for Populations by Existing Professionals		
			Service Academies		
			Establish Accommodating University Polices		
			Establish separate, Collaborative Institute		

Great Lakes Workshop

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Information Need/Gap	What	Why	Where	Technologies	Interest
Life in one cubic meter of water	Seasonal change, species change, ID & characterize, transition rates, feeding rates, all of the rates	Ground truthing, comparison between different biota, symbiosis, sensor development (based on mother nature)	Contrast temperate vs. tropical, nearshore fresh vs. salt, contrast different parameters	AUVs, ROVs, subs, sampling, neutrally buoyant chemostats, low impact, low Reynolds #, new tech	1
Archaeological Survey & Documentation	Location; documentation, evolution of marine tech, 19 th century, effects on bio (good time measurement), influence of currents, also look at known wreck sites	Largest density of shipwrecks & submerged cultural resources, need to be protected & managed	Throughout Great Lakes, deep water, Lake Michigan, Thunder Bay (already have resources) Lake Champlain, Lake Superior, Death's Door, ports, Keweenaw Peninsula	Interactive (w/ public) cameras, ROVs, multibeam, subbottom profilers, magnetometer, LIDAR, deep diving cold water diving	2
ID Prehistoric Submerged Archaeological Sites	Paleolake lines, ID sites, location, arch documentation	Earliest arch sites in region, better understanding of prehistoric life & tech	Nearshore Karst features, Straits of Mackinaw I, submerged river mouths, paleolake levels	Std, predictive modeling, side-scan sonar	2
Benthic Communities	ID & characterize interaction, effects of exotics, impact of fisheries, compare w/ oceans, food web	Failing in lower Great Lakes, need to understand why: Superior (untouched), fragile, have ignored benthic fishes in food web	Lake Superior, compare with Chesapeake Bay and Gulf of Maine	ROVs, Subs, sampling, AUVs	3
Abyssal Fish (> 50m)	Life history, impact of invasive species, spawning (where & how especially in winter season), character displacement behavior	Know very little, gene flow problem, recruitment problem, invasive species problems, displacement behavior	Upper Great Lakes, Superior, Huron, Michigan, eastern basin of Lake Erie	ROVs, AUVs, time lapse camera systems planted on bottom in strategic locations, Subs	3
Mesoscale Eddies – frequencies & importance	Current flow patterns, eddies, mixing process, impact on bio, frequency & importance to ecosystems productivity, Chem. props	Need to understand input on ecosystem; inference of global warming, correlation productivity, gene flow, recruitment, impact on benthic communities	Lake Superior, other Great Lakes, Yellowstone Lake	Current meters, satellites, ADCP moorings	4
Linking Climate Forcing to Lake Response	One effort across all lakes, temp, current, wind speed, barometric pressure, real time chemical composition	El Nino, global warming, understanding international variability, lake circulation questions, variation over lakes, better understanding of sediment record for paleoclimate, transport of toxics & nutrients, connection w/ boat people (outreach)	Ten largest lakes in the world, Lake Michigan (start where there are problems), need to be strategically position, Lake Champlain, Yellowstone Lake	Buoys, ADCPs, various sensors, mass spectrometer, wireless comms, real-time web access	4
High Resolution Spatial & Temporal Zooplankton Measurement	High resolution zooplankton measurement over space & time, classification	Major component of the food web depend on fresh water body	Compare Lake Superior and southern Lake Michigan, 10 largest lakes in the world, Yellowstone Lake	Bigger faster vessels (stationed in Lake Superior), optical plankton counter, towed vehicles, AUVs w/ zooplankton counter, in-situ genetic tech, video image classification tech	4
Carbon Cycling in Lakes	Carbon cycling, primary productivity, Carbon accumulation, Carbon consumption, compare among lakes	Test hypothesis of carbon cycling, each lake is a comparative experiment	Lake Superior, Lake Michigan vs. other lakes	Std, AUVs, primary prod techniques, sediment traps	5
Mapping	Mapping, multibeam	Foundation for exp, small portion of lake bottom mapped, insight into deep water circulation & sedimentation patterns	Lake Superior, Lake Michigan, all the lakes, Yellowstone Lake (done this year), Crater Lake, African Lakes	Acoustic mapping, magnetometer, subbottom profiler, ROVs/Subs	6
North/South Ridges in Lake Superior	Origin controversy, distribution of sediment & benthic communities, distribution of fish, influence of bottom currents	It's a major unknown in Lake Superior, lake is heterogeneous; ID these boundaries	Lake Superior (eastern half), northern Lake Michigan, eastern Lake Huron, Bering Sea	Mapping, ROVs, Subs, AUVs, sampling, moorings (ADCP)	6
Karst Features in Lake Huron (sinkholes)	Spatial coverage, depth, dimensions, biology, chemistry, local flow pattern	Potential source of groundwater input, fish habitat, prehistoric culture	Central Lake Huron	Standard, mass spectrometer	6
Ring Depressions (400-500 m across; 20-30 m deep)	How they formed, influence on distribution of benthic communities, sediments, contaminants, local flow patterns, why not in other lakes	Most widespread feature on floor of North America's largest lake	Lake Superior	Seismic reflection profiling, ROVs, sediment coring, subs	6
Artificial Reefs	Recruitment, deterioration of cultural material, environmental effect, new vs. used, lab	In fresh can do well controlled experiments	Artificial reef sites e.g. not too much fishing or commercial activity	Active acoustics, std, video, dive	7
Climate Change on Timescales of Decades to Millennium	How climate varies in space & time	Relevance to societal needs (e.g. global warming to inter annual trend prediction), higher resolution than ocean cores	African Rift Lakes, other large lakes of tectonic origin	Drilling, Heave compensation and dynamic position or deep water anchoring	8

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Information Need/Gap	What	Why	Where	Technologies	Interest
How Animals use Vision & Light to Orient Themselves in the Water	Visible communication	Know very little, spin-off potential for other technologies, dictate habitat utilization, mating	Deep water, shallows, freshwater vs. saltwater	Standard, photon cameras	9
Hydrothermal Features in Lake Systems	Chemistry, microbiology, nutrient dynamics,	Interesting microbiology, biotech, evolutionary aspects, bioremediation, oceanographic power source for sensors	Crater Lake, Yellowstone Park lakes, African Lakes e.g. Tanganyika, Baikal	Standard	10
Evolutionary Biology	Endemic species, evolution in isolation, interlake comparisons, genetics in large time scales	Fundamentals of evolution of life, island biogeography	Lake Victoria, Lake Malawi, other African lakes, Lake Baikal, compare w/ Great Lakes	Genetic tech, microbiology techniques, capture techniques	11
Seeps/ Non O2 Environments	Same as above	Same as above (except power source)	North shore of Lake Superior, bays, near shore, upper peninsula Superior, Ashland port (Ch..sp?), urban environment	Standard	12
Issue: How do we share archaeological info w/ the public?					
Issue: AUVS have big potential in lakes					
Issue: More use of cross discipline					

Worksheet B: Identify Approaches to Address Priority Exploration Information Needs

Standard Package: Class IV Vessel w/ Acoustic Mapping; Dive Capability (ROV/AUV/Submersible) w/ Imagery/Video and Sampling Equipment; Precise Positioning System

Standard Partners: EPA; GLERL; Ohio State; Grand Valley State University; Canadian Center for Inland Waters; Canadian Dept of Defense & Coast Guard; Great Lakes WATER Institute; U Mich; Large Lakes Observatory; Mich Tech; USGS; USCG; Univ of Toronto; Illinois Natural History Survey, Departments of Natural Resources

Worksheet B: Identify Approaches to Address Priority Exploration Information Needs

Information Need - Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
Life in 1 m³ of Water					
IR Laser Scan (100 m res) then Holography (1 m res), 10 year effort	IR laser scan on random samples then holography - take random samples	High but very feasible & low risk	Holography, acoustic Doppler, Std pkg, DNS, fluid simulation, IR laser scan (need low Reynolds# on machine), microchemical sensors	John Hopkins, URI	Scientific: new biota; micro level of how oceans work. Industry: tech approaches are unlimited. Outreach: media (e.g. BBC, Discovery Channel). Regulatory: better vessel management program; bioterrorism.
Archaeology					
Funnel	Broad based survey; then document sites (impt)	L to H depending upon target	STD Pkg, tech divers, acoustic/laser vision system, magnetometer, modeling=Lake level studies	East Carolina University, museums, historical societies, industry, philanthropy, Thunder Bay NMS, Office of Naval Research, Std partners, Smithsonian, academia (Anthro), Native American groups	Scientific: same. Industry: vision system. Outreach: public interest, K-Gray, unlimited, more for prehistoric. Regulatory: management & protection
Targeted	Existing data then document sites (model storm data)	Same as above			
Benthic & Abyssal					
Funnel	Acoustic mapping then ROV work to isolate habitats, ground truthing, sediment, characterize	High	Acoustic scanner, Std pkg, long term video (obs), obs platform (obs), time lapse cameras	Std Partners, Scripps, industry (esp finances - power plants, fishing, fishing support), boating industry, Sea Grant Extension (outreach & funding), Jason Project	Scientific: knowing mating game, life history, what's limiting recruitment, learning more about diporeia decline. Industry: power plants (big time) (e.g. zebra mussel issue), municipal water plants, carbon cycling. Outreach: "huge", public concern, education need. Regulatory: fisheries management, water quality, contaminants
Targeted	Use existing data, groundtruth & characterize	High			
Moored Observation	Moored in key habitat; taking measurements	High (higher risk in winter)			
Mobile Observation	Esp in Winter; ROV/AUV along transect, moving to find key conditions then observe	High (higher risk in winter)			
Eddies/Climate Forcing/Zooplankton					
			Instrumented moorings, drift buoys, ADCPs, instrument arrays, acoustic imaging, STD Pkg, sediment traps	Std Partners, University of Toronto, Oregon State University, Scripps, WHOI,	Scientific: same as yesterday plus fish recruitment. Industry: lake level variations greatly impacts commercial shipping directly. Outreach: std pkg, education, inspiring kids, computer literacy related to science vs. games. Regulatory: major impact on lake level and fisheries management, on tourism protection, on water resource management
Targeted Obs	Choose one location and measure eddies/zooplankton, modeling	High (low risk, comp cost)			
Funnel Obs	5 places in one of large lakes; see how lake responded over two years and choose detailed location and study eddies and zooplankton, modeling	High (low risk, comp cost)			

Worksheet B: Identify Approaches to Address Priority Exploration Information Needs					
Information Need - Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
Add Yellowstone Lake under "Where" list					
Interesting Places					
Funnel	Acoustic mapping, choose sites, ROV, imaging, sediment coring, benthic char & mapping	High	Std Pkg, latest ROV tech, moored instrumentation, ADCPs, acoustic fish finders, modeling	Std Partners, oceanographic institutions, Canadian Geological Survey, industry, Thunder Bay NMS (Karst)	Scientific: new and not understood, same. Industry Outreach: "very cool", potential glamour child. Regulatory: might need to be protected.
Targeted	Choose sites, ROV, imaging, coring, benthic char & mapping	High			
Observation	How conditions change over course of year, instrument mooring w/ current meter arrays, various sensors	High			
Artificial Reefs					
Comparison Study	Before and after comparison (underwater lab concept)	High	Std Pkg, moored sensors & instrumentation, time lapse video, divers (SCUBA), reef design	Std Partners, industry, DNR, University of Waterloo, Fish&Wildlife Service, tourism, recreational divers, University of Windsor	Scientific: same, how reefs interact w/ environment? Industry: aquaculture, recreational diving, biofouling research, charter boat industry (sport fishing). Outreach: very visual. Regulatory: depends on results, should they be doing it or not.
Observation	Watch over time	High			
Targeted	One time examination of new/existing artificial reefs (shipwrecks)	High			
Issues & Notes					
Lack of precise dynamic positioning system aboard vessels					
Blue Heron (87'), EPA vessel (160'), Laurentian (87') = good lake vessels for OE					
How do we educate people on issues in Great Lakes; do not have glamour of the ocean; including choices of what is funded					

Worksheet A: Identify Ocean Exploration Information Needs/Gaps - Great Lakes					
Information Need/Gap	What	Why	Where	Technologies	Interest
Lake Biodiversity; Bio / Geo / chemical processes; origin of Lakes; Origin of species (Evolutionary processes)	Community structures & compositions	Undiscovered areas of bottom; findings new species of Great Lakes; Global Pressures on fresh water resources; Global issues and local pressures on fresh water resources;	Bla Kal Lake; African Rift Lakes, Lake Nicaragua, Great Bear, Great Slave Lake; Titikacica Lake; Yellowstone	Pharmaceuticals	1
Pelagic Habitat - Ecosystem Behavior's; Both physical systems and Benthic Landscape	Intensify systems in time and space scale; Global loss of biological diversity (loss of taxonomy and systematics skills) Human Technologies to resurrect core competence and Knowledge, people & technological interface needed to continue the skills (greater diversity in program - mainly older / white males)	Unknown connections between habitat & behavior; Management Questions (make it exciting for everyone to spend 10% on education & outreach - needs to be automatic, Information technology as part of funding; Interface of scientist and education, Lead time to ensure relevant content; It won't happen with only a bunch of lone rangers	Biological hot-spots (Benthic & Pelagic Water Columns)	Sensors & Critter Cams - PSATS	2
Biological Transitions Zones; Populations in flux; transportation of organic and inorganic	Identify organisms transitions zones; zebra mussel migrations; mapping of systems	Global climate changes, fish species mobility, numbers; Ranges decline of organisms; Changes in Biodiversity	Green Can Reef; Coastal areas, sea grasses, mangroves, Florida Bay	Time Lapse; Acoustic Imaging of sediment layers; microscopic level	2
Integrating in discoveries with accountability Need, Basic research with applied science; Event driven Storms, Surface and Benthic storms;	Distribution of nutrients, biomass & current influences	Important for costal zones; Social economic relevance;	Costal Harbor Estuaries	Moorings (Long Term); High frequency surface radar (CODAR), ADCP's; Development of ecological observatories with (beyond normal sensors); New engineering - adaptive sampling instrument (What, When);	2
Linkage in the atmospheric forcing function; Marine boundary levels influences; Different processes to study and couple to ocean processes cores and eddy's (rings)	Forcing functions in atmosphere; Air - Sea interaction for the exchange of gas mass constitutes;	Driver of Ocean changes; Using the lakes as a closed system for the development of models to build prediction models (small scale processes in the water and air) - Easier to study (logistics)	Translate atmosphere studies techniques in the ocean	New Measurement techniques (RADAR or Lidar)	3
Discover new bio / geo /chemical pathways (distribution in the physical sense)	Identify pathways for compounds	What compounds are influencing the environmental from remote area	Least likely place	Indicator compounds exploration; measurement systems; Platforms for opportunities	3
High Resolution mapping of Great Lakes	Surveys	Discover new features	Large Lakes	Use of UNOLS w/multibeam	4
Cultural resources; Pale Archeology of basin and human interactions	Identify shipwrecks; Submerged shorelines	Increases connections to fresh water and appreciations of Great Lakes resources; Understand dynamics of region	All the Great Lakes basin wide; Green Bay; Saginaw Bay - Deep Water	Better/ Faster multibeam systems	4
Things that live between the rocks	Limited sampling of difficult areas; Deep Reef systems; out crop reefs	Undiscovered areas of bottom; findings new species of Great Lakes	National & International; Large Lake Areas	Small cameras & fiber optics; sucking mechanisms; Different type of new technologies for sampling techniques for heterogeneous area; Sensors have ability to describe the physical substrate in 3 dimension sense	5
Constant monitoring of Pelagic community	Buoy Networks, or an upward looking devices to monitor water column	Unknown interactions in the water column	Lake Michigan for comparison of Older transects	More Adaptive sensors following events	6
Recharge of the all component parts Lake systems, Linkages of rivers estuaries and basin	Use of streams for spawning; Ecosystems approach to water quality; Examine revival of species, Pollutants	River run-off; linkages between estuaries and river fauna, biota complexity issues unique to the freshwater Lakes systems we drink; Land use policies - regulations; water sheds;	Test cases in South East Wisconsin; Collaborative efforts Canada other International entities	Modeling technologies; Maintenance of USGS gauge stations; Broad scale monitoring	7
Charactering ecosystems and other systems; Ice Dynamics	Surveys sampling; systematic surveys; Four dimension; Hydrothermal systems; long term sediment records; rates of change; Seasonal Ice covered areas	Unknown Balance of physical and biological processes; study of ice dynamics	Deep Basin to shallow water volumes; Winter in Great Lakes	Molecular systematics genetics (method to measure diversity); Environmental Tracers	8
Coupling of Modeling and Measurements; Sample strategy/ bio / currents / Atmosphere models -	Areas of gradients (where do you put the resources) at biologically dynamic areas	Citizen science; Balance of empirical measurements with models; helps in planning with catch per unit	Identification models to lead to examples (NASA sulfur model)	Using cruise ships and instruments (Car Ferry towing instruments) Acoustics, sampling water, Image	9

Worksheet A: Identify Ocean Exploration Information Needs/Gaps - Great Lakes					
Information Need/Gap	What	Why	Where	Technologies	Interest
Models can drive questions researchers to answers		effort; verifies the conceptual of the measurements that will be made; environmental predictions; tracking of biological changes; provides a way to bring modelers and empirical measure researchers together (pattern recognition); physical modeling drives biology;		shadow image analysis, microwave radar on bow of ship to measure surface roughness, small scale of hyperspectral imaging; Environmental Tracers	

Information Need - Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
Comparative Lake Biodiversity & Complexity					
Funnel Approach (Phase 1 on several lakes)	Multibeam survey; Physical Ocean sampling; Natural History Survey	Medium	ROVs / AUV / SCUBA / Submersibles / Hyperspectral Remote Sensors; In-Situ Sensor (Long Term); Small Vessel for Estuaries;	National Geographic; USGS; Country of Lake; Smithsonian; UNEP, UNGEF (United Nations); Developing Nations Organizations;	New Species; Bio-Technology; Fundamental Ecological Principles to Apply to Management; Outreach Human connection to Water Resources; Public Health
Ecological Comparative Functional Group Approach to compare communities with similar landscapes between Lakes; (e.g. Lake Superior: young v.s. Biakal; Old)	Describe landscape census; Looking for midwater scatters	Medium	High Frequency Mid-Level Acoustic Census	National Geographic; USGS; Country of Lake; Smithsonian; UNEP, UNGEF (United Nations); Developing Nations Organizations;	New Species; Bio-Technology; Fundamental Ecological Principles to Apply to Management; Outreach Human connection to Water Resources; Public Health
Targeted Approach on Specific Lakes for Specific things;	- Species Diversity - looking for new species; (3 African Great Lakes); Rapid Assessment survey; Collection of long term Sediment cores; Geo-thermal Vents Systems	High	Digital Imagery	National Geographic; USGS; Country of Lake; Smithsonian; UNEP, UNGEF (United Nations); Developing Nations Organizations; DOI, USGS BRG; Museums	New Species; Bio-Technology; Fundamental Ecological Principles to Apply to Management; Outreach Human connection to Water Resources; Public Health
Pelagic - Benthic Landscapes, Habitats & Environments					
Focused Applications like the Comparative Funnel Approach with a higher resolution. Details in Ecological Comparative functional Group Approach. [Merge with Interest #6 in winter	Time Series Observations; Investigate during dynamic periods of change "Season of Storms"; Identification of Transport Sampling; Identification of change to community structures across taxonomy;	Medium	Zoo Cam's, Fish Cam's; Buoy Networks, or an upward looking devices to monitor water column; Dockable AUV's; Recycle Oil Rigs on Mid-Lake Ridge; Long Term Observatory	Satellite - National Weather Service; Gas & Electric Industry; Coast Guard, Navy & Army Core of Engineers; NSF, DOI, USGS; Insurance Companies	Understanding Lake Systems; Risk Management of Coastal Resources; Defense Transportation; State Defense National Resources Management; Fisheries;
Discover Bio / Geo / Chem Pathways Air / Sea Interactions					
Discover Bio / Geo / Chem Pathways Linking Atmospheric Forcing coupling of Ocean processing		Identifying boundary fluxes; Identify microscale of physical / chemical processes; eddys & fronts; Data mining & modeling;	Next generation of "FLIP"; Smart Sensors; Swath vessel; Remote Sensing; Super Computer	Navy, Energy Industry, Marine Transportation; EPA; National Weather Service; Canadians	Mass balance understanding in the Great Lakes; Contaminant Transportation; Coastal Meteorological models (Ground Truthing); Marine Weather Prediction; Fisheries
High Resolution Mapping of Great Lakes & Paleo Archeological of basin and human interactions					

Observation & Funneled approach	Survey of bottom of Great Lakes - Shallow water mapping; Extention of Coastal Estuaries & Wetlands; Understanding substrates to particle size;	Sub-bottom profiling; using side scanning sonar; Seismic survey; Hyperspectral Imaging from Aircraft; Laser Line Scan	National Oceanographic Service; Army Core of Engineers; USGS; Power Industry Energy; museums	Discovering where stuff is; Navigations; Fisheries; Cultural Heritage (Climate history, Lake Levels, down stream mouths & Inundated cultures); Identifying Exploration Targets; Road maps for research; Inferring Lake processes boundary conditions
Mapping of Great Lakes	Near shore fossil coral reefs (Chicago and similar environments); east-end of Lake Superior; Mid-Lake Reefs; Mid-Lake ridge through Lake Huron; Lake Champlain			
Things that Live between the Rocks				
Targeted Area	Survey of bottom of Great Lakes - Shallow water mapping; Extention of Coastal Estuaries & Wetlands; Understanding substrates to particle size;	Miniaturized exploration / sampling techniques; Fibre optics & Subs, ROV's, AUV's; Dynamic Positioning Systems or ROV's / AUV's capabilities	WHOI, Harbor Branch; NGS	Camera Manufactures
Near shore fossil coral reefs (Chicago and similar environments); east-end of Lake Superior; Mid-Lake Reefs; Mid-Lake ridge through Lake Huron; Lake Champlain; Discover origin an maintenance of Reef Dynamics; "Exploring our Groins"				
Crosscutting Technology				
Rapid Scanning Electronic Microscope (Flow-cam)				

South Atlantic Workshop

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Group 1					
Information Need/Gap	What	Why	Where	Technologies	Interest
2. Mapping paleoshorelines and relict reefs (tend to be fish habitats)	Map, ID, characterize, develop baselines for geology, biology, water quality	Understand sea level and paleoclimate changes, foundation for essential fish habitat	Reefs, W. Florida shelf, Keys, shorelines everywhere - shelf edge, Bahamas	bottom sampling, multibeam, subs, side scan, seismic tech, chirp sonar	1
8. Inner shelf	Surficial geology, bathymetry, sediment distribution, biota, habitat distribution, potential fish habitats, groundwater discharge, relationships between biology and geology, physical oceanography - water mass characteristics, invasive species, harmful algal blooms	archaeological potential, sand resources, understanding fish habitat, designate protected areas, hurricane impact - coastal hazards such as erosion, rapid response to natural or man-made catastrophic events, paleoshorelines - coastal evolution	Grays Reef, Georgia coast, Florida coast, SE NC coast least studied, SC coast	SCUBA, multibeam, side-scan, chirp, ROV's, seismic, satellite, Lidar, vibracore, SUB, AUV, basic bottom sampling, moored arrays, multispectral platforms	1
10. Explore canyons and holes	map, characterize, ID, turbidite transport, mineral exploration, gas and groundwater seeps	Unknown, unique isolated habitats, results of unusual geographic processes - history of continental margins, how do they affect oceanography and biological assemblages	Hatteras, Carolina sea trough, Desoto canyon, the Point off Cape Hatteras, Red Snapper Sink Hole - off Jacksonville	Subs, tech diving, sonar, seismic, side-scan, multibeam bathymetry	1
11. Explore shelf break - upper slope	mapping, characterize, ID, intercomparisons	baseline characterization, very productive areas, EFH, upwelling zones, potential for mass wasting, tsunami generation, chemosynthetic communities, fluid flow, evolution of continental margin, mapping low stand deposits, influence of Gulf Stream	S. Atlantic Bight, oculina banks, compare among . . . Cape Canaveral, Hatteras Slope, S.Carolina-Georgia border	Subs, tech diving, ROV's, AUV's, moored arrays, multibeam, side-scan, seismic, chirp	1
16. The Point	extend baseline info, why is it so productive?, map,	unique - meeting of three water currents, very productive, huge potential for natural gas	Just off Hatteras	Subs, mapping, sediment traps	1
12. Bahama Banks	Explore mechanisms behind whiting events, sea level studies, geology, karst studies, low standing reefs, archaeology - shipwrecks, reef studies, coral bleaching, carbonate production, reef sampling/coring for sea level and paleoclimate studies, highly migratory species, fisheries oceanography	Whiting events unknown - Calcium Carbonate in water column, lots of interesting geology, shipwrecks, goes to great depths over short distances - basic exploration, unique, educational applications, carbonate bank evolution, fisheries - provides connectivity to rest of Caribbean, general coral reef health	Tongue of the ocean (TOTO), Florida Straits, Exumas (island chain)	ABLOS (a boat load of stuff), SCUBA, Aquarius and other habitats, remote sensing	2
13. Expanding fisheries (exploitation of new species)	Life history, reproduction, growth rates, all base-line information, education effort	Need baseline information for management of newly exploited species	Opportunistic, region-wide	baited traps, trawling	3
1. SAFMC (South Atlantic Fisheries Management Council) putting areas on map for proposed marine reserve areas - politically driven. Need to explore these regions to ID whether these are appropriate reserve areas biologically, ecologically, etc.	Map, ID, characterize, develop baselines for geology, biology, water quality, determining potential recreational interests, oceanographic parameters	Little is known about proposed regions - most are deep regions, greater than 50m; huge management implications - could fail since they are based on political decisions;	SAFMC has maps, deeper ones off N. and S. Carolina, Georgia, Florida, Gulf of Mexico	Multibeam, AUV, ROV, subs, tech diving, permanently mounted instrument arrays	4
3. Recruitment and spillover mechanisms in MPA networks	Oceanographic parameters/processes, info on spawning, eggs, larvae spillover and transport mechanisms, behavior of early life history stages that effect recruitment	Little known about regions/mechanisms	Region-wide, spawning locations, paleoshoreline ridges such as Pulley Ridge, Dry Tortugas, MPA's and adjacent areas, Charleston Bump	Nanotechnology, AUV (WHOI), multibeam, subs, satellite tags on spawning fish, drifters, moored arrays	4

Worksheet A: Identify Ocean Exploration Information Needs/Gaps

Group 1

Information Need/Gap	What	Why	Where	Technologies	Interest
9. Oculina Banks	What is effect of closure? 10 yr limit on no fishing, ID, characterize recruitment and spillover mechanisms, artificial reef impact, comparison with existing baseline studies	Only MPA in S. Atlantic Bight where fishing is not allowed, huge oculina coral region, deep reef at 300ft, oculina destroyed by shrimp trawling and scallop dredging, efforts to reseed right now, will coral self recruit?, unique habitat, assessment of restoration techniques, still don't know a lot about it, no research funds provided to demonstrate effectiveness of MPA in restoring corals and fishes, so needs funding	S. Atlantic Bight	subs, ROV's, tech diving, multibeam, moored arrays, side-scan sonar, chirp	4
4. Exploring Gulf Stream and Florida Current	ID, characterize, map, habitat assessment/map, nutrient cycling, life history/reproductive biology/evolution of life history strategies of fishes	Blake Plateau - Deep, under Gulf Stream/Florida Current, lots of new species found there, difficult access. Portales Terrace - lots of fish habitat. Unexplored regions	Fauna of Blake Plateau and Portales Terrace and other significant deep regions in Florida Straits, Miami Terrace	High current subs, ROV's, side scan, multibeam, seismic tech, ADCP, moored instruments, sediment traps, neutrally buoyant sed traps, NEW TECH: develop baited fishing gear - automatic release fishing gear such as magnesium links that dissolve - needs to get to bottom quickly and do it's job of fishing or photographing and then pops up to the surface when done	5
15. Deep sea coral mounts (oculina and lophilia)	map, associated fauna, area, extent, size of mounds, new species	bioprospecting, unknown, new species, MPA implications (?)	400-600m depths, Blake Plateau - Cape Fear to Bahamas	Subs, sonar, sampling tech	5
14. Shelf-wide water column oceanographic studies (physical, biological, chemical)	what causes harmful algal blooms, circulation, nutrient distributions, nutrient flux, mixing, recruitment dynamics, jellyfish (sea nettles)	fisheries impacts, economic impacts - recreation, spawning and distribution patterns, baseline data for rapid response	Region-wide, N. Carolina, Onslow Bay	SABSOON, data buoys, satellite imagery, drifters, general oceanographic sampling - CTD, ADP, water sampling	6
17. Seasonality of upwellings and associated spawning and larval distribution	map locations of upwellings and gyres, measure productivity, sample plankton, measure vertical flux to sea floor, physical/chemical water column characteristics	to understand importance of upwellings, explain or predict recruitment to fisheries, effects on estuarine systems, life history	N. of Cape Canaveral, N. of Charleston Bump - semi-permanent gyres, also smaller ones but don't know much about them - unknown areas	data buoys, moored arrays, satellite, plankton sampling, sediment traps, standard oceanographic sampling - CTD, ADCP, fluorometry	6
5. Bioprospecting	Collect samples of marine organisms, water samples, sediment samples, collect DNA from marine organisms	Need for new pharmaceutical compounds such as antibiotics	Any of regions/projects stated above - opportunistic	Subs, ROV's, low tech shipboard sampling such as trawls and dredges, genomic tech, molecular tech	7
7. Mineral prospecting	manganese nodules, phosphorites, gas hydrates, sand resources for beach nourishment, heavy metals	new energy sources, new mineral resources	Near-shore regions, Region-wide, off Hatteras, Charleston Bump, Blake Plateau, Blake Ridge	Multibeam, Chirp sonar, seismic, ROV's, subs, bottom sampling, corers, grabs, dredges, side scan	7
6. Use example from sheet on chemosynthetic communities		New resources, potential energy source	Blake Ridge, Gulf of Mexico		8
Standard protocol for sampling and data management/storage					
Do's and don'ts of wreck diving - educational campaign					

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs		
Group 1	Standard package: class I/II vessel with acoustic mapping (multibeam, sidescan), dive capability (ROV/AUV/Subs) with imagery/video and sampling equip, precise positioning equipment, real-time information transfer (video, email, web), GIS, bottom samplers, grab samplers, water column sampling - rosettes, CTD, plankton sampling, fish sampling	Standard partners: Universities, USGS, state depts of natural resources, NMFS, NOAA sanctuaries, Sea Grant, NOS, MMS, WHOI, HBOI, NASA, NSF, ONR, Space Grant, COSEE, OE, Army Corps of Engineers, aquariums, museums, archaeologists

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Group 1					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
Bahama Banks					
Submerged habitats	many habitats to observe different regions	medium	coring, sediment traps, water column sampling, std pkg, 3-D seismic, lidar	std partners, CMRC (Caribbean Marine Research Center) at Lee Stocking Island, San Salvador, education partners, Bahama gov't	scientific – new knowledge, increased understanding of climate/sea level change, see 'why' from day 1; outreach – great opportunities, public interest; industry – fishery, recreation, tourism; regulatory – fishery
funnel approach	using ships, satellites	high			
targeted approach	sea level data, sediment traps, water column sampling	high			
observation approach	satellite based, remote sensing	high	satellite, remote sensing, lidar		
tracking	satellite telemetry	high	tags		
critter cams	critter behavior	high	cameras		
Shelf to Upper Slope					
observations	moored arrays, satellite, airborne, lidar, drifters	med-high	moored (similar to LEO), ROV observation satellite, airborne	std partners, Oil industry, ocean tech companies, DOD	science – observation studies, see 'why'; outreach – get students out to sea – lots of opportunities, relevant region – in our back yard; industry – recreational, fishery, tourism; regulatory – coastal erosion, fishery, MPA's, regulation of shipwrecks
funnel	broad based exploration survey, expansion of marmap monitoring (fisheries monitoring program funded by NMFS to SC)	med-high	std pkg, MOCNESS funnel, seismic		
targeted	shelf edge, reefs, hard bottoms, paleoshorelines, spawning locations, sand resources, sediment traps	high	sediment traps, coring		
New tech – mobile habitat (withstand ; baited autonomous trap; drifters released from sea floor	habitat based observation	medium	habitat, SCUBA		
shipboard experience	dedicated estuarine coastal vessel for education and training of next generation of oceanographers to establish monitoring program of data and sample collection – potentially re-outfit Ferrell for this purpose	high			
Expanding Fisheries					
	baseline information such as growth rates, reproduction, etc.			Standard partners, SAFMC, industry associations such as Coastal Conservation Association and other sport fishing clubs, commercial fishing associations, REEF Environmental Education Association, PADI, NMFS	scientific – see 'why'; industry – sustainable fisheries; outreach – great educational opportunities; regulatory – sustainable fisheries
fishery dependent sampling	getting samples from landings	high			
fishery independent sampling	conducting independent surveys to get better estimates of abundance	high	standard package, MOCNESS		

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs

Group 1					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
MPA's and EFH's			standard package	Standard package, Islands in Stream, OE, ocean tech industry, NMFS, habitats used in Monitor project	scientific – determining effectiveness and design of MPA's, see 'why'; outreach – public relations, multidisciplinary, lots of opportunity ; industry – lockout tech could be valuable to industry, sustainable fisheries ; regulatory – better ability to designate MPA's
funnel	standard funnel package	high	SCUBA, tech diving, lock-out diving from subs		
Targeted	standard targeted				
Tracking	track larvae and fish	high	nanotechnology, satellite tags, SCUBA, tech diving		
Observations	moored arrays, satellites	high	moored arrays with video, satellites, time-lapse video		
passive acoustics	passive acoustic tech	high	passive acoustic array		
Gulf Stream/Florida Current				standard partners, NWS (especially moored), recreation community, fishing, boat industry	scientific – see 'why', don't know a lot about dynamics of Gulf Stream, better forecasting; industry – storm warning and hurricane prediction, fishery, recreation, tourism, diving community; outreach – huge educational/public relations potential; regulatory – sustainable fisheries, seasonality of fisheries
funnel	standard funnel	high	standard package, baited autonomous release traps (new tech), ADCP		
targeted		high			
observation	moored current meters at multiple depths, sediment traps	high	AVHRR (sst), SeaWiFS (ocean color), satellites, sediment traps		
drifter	release drifters regularly from position on the sea floor and use satellites to track them	high	neutrally buoyant drifters		
Shelf-wide Water Column Studies					
funnel	standard funnel, water column sampling	high	standard package, moored arrays, upgrading and expanding the SABSOON network, ADCP, permanently moored data buoys, drifting sediment traps (vertex style)	standard partners, CDC	scientific – see 'why'; industry (HAB's mostly) – tourism, recreation, fishing, toxicology, pharmaceutical, biowarfare; outreach (HAB's) – public information; regulatory (HAB's) – fisheries, tourism, recreation
targeted	standard targeted, water column sampling	high			
observation- regular	time-series monitoring and collecting water samples	high			
observation – event driven	monitor as event occurs	high			
Prospecting			rock dredging, sand collecting tech, standard package, seismic, sub-bottom profilers, bioprospecting tools	biotech, CDC, Standard partners, local governments	scientific – new information, resource ID, oceanographic processes; industry – tourism, recreation, biotech; regulatory – local governments, coastal zone managers; outreach – conservation of resources
funnel	standard funnel	med-high			

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Group 1					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
targeted	standard targeted, Charleston Bump (mg), Blake Plateau (gas hydrates, sand), inner shelf,	high			
Other needs: central sampling repository; central repository for data					
NEW TECH – Improve tech for lock-out diving					

Worksheet A: Identify Ocean Exploration Information Needs/Gaps						
Group 2						
Information Need/Gap	What	Why	Where	Technologies	Interest	Item #
Shelf to slope transition area; complex habitats – reefs (outer shelf), deep coral banks, canyons	multidiscipline surveys; fisheries; ID community structures; (Assume already have good bathymetric data); characterize content of entire water column (*planned comprehensive surveys); *staged multiyear plan , generate time line	impact of cable laying; oil industry; lack of knowledge of biodiversity; pharmaceutical interest (sponge communities)	Hatteras to Texas	multibeam; ROVs; sampling technologies; HDTV; subs in strong currents; remote sensing of Gulf Stream	16	3
Primary & secondary fish production; understanding geochemical processes	eddy processes; ID drivers of production; lagrangian perspective; food web	management of living marine resources	Charleston Gyre	satellite imaging of SST, SeaWiFS; multidisciplinary ship time; drifters	16	4
Connectivity of habitats on shelf and edge of shelf; trophodynamic study	extent of spawning areas; inventory of habitats and communities; connection between reefs	unknown establishment of MPAs; understanding of energy flow; status/impact assessment	marine protected areas; Hatteras to Texas		16	5
Submerged cultural resources – document status of wrecks; recently uncovered by storms, etc.	systematic surveys; ID targets; consistent survey of coastline areas out to EEZ	management tool; can't protect or investigate what you don't know; historical importance; driven by technology which has allowed public to conduct surveys; prioritize value	Hatteras to Keys; USVI	multibeam	11	1
Mapping currents and eddies and their connection to vertical and horizontal components	ID circulation, temperature discontinuities, current velocities; pH levels	transportation of organisms; ID shipwreck status; effectiveness of no fishing areas	Gulf Stream to inlets	satellites for SST; drifters; buoys; ADCP; AUVs	11	8
Discovery of deep sea minerals, deep sea biota	surveys – subsurface; ocean drilling programs	undiscovered; potential natural resource, cable laying process	Blake Plateau		10	9
Map dead and living muscle & clam communities associated with seeps	compare with subsurface; ID survey	ID habitat impacts; understand the differences in communities between Blake Ridge and Gulf of Mexico	Blake Ridge	multibeam; coring; sub; gas hydrate sensors	10	2
Post data collection access to data/info	central coordination of data repository; coordination with P.I., collaboration among P.I.s to share and publish data; funding for working up data; requirements in grant awards – metadata generation, timelines (derived products vs. raw data); data management system process for collected data – soft data, hard data (jars of samples), data products; graduated approach with sufficient funding	public and other organizations need access to Ocean Exploration mission results; support for direct outreach initiatives	anywhere accessible	GIS; distributed data management systems	6	6
Automated data and metadata system	bridge / ship info feeds into automated / integrated system for cruise report; station data		information systems for ships			7

crosscutting themes:
 metadata clearinghouse as data organization process
 scientists are at a disadvantage w/ industry when the industries have more data than the science community

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs		
Group 2	"Standard" Package 1 - as described on handout + magnetometer, sidescan, sub-bottom profiler, flow thru system; "Standard" Package 2 - NR1 submarine like vessel; "Standard" Package 3 - mobile habitats	"Standard" Partners - USGS, National Park Service, Navy, States, Universities, SHIPO (State Historic Preservation Office), NMFS, NOS, industry, media, educators, Sea Grant, NASA, NESDIS

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Group 2					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
Shelf to slope transition area; complex habitats - reefs (outer shelf), deep coral banks, canyons					impact assessment
1 - funnel approach	survey bottom; physical sampling of water column dynamics	high (\$\$)	std pkg 1 minus sub	std partners	historical / educational use; industry - ID new things; protection (regulatory); scientific new knowledge, better understanding
2 - targeted	biological survey; sampling structural data; describing wreck structure; wood samples from wrecks; corrosion analysis; sampling substrates, subsurface geology	high - std pkg 1; low - std pkg 2, 3	std pkg 1, 2, 3; HDTV cameras; photo mosaic	std partners	scientific; industry; new species; gas chemistry; resource management
3 - observation	site stabilization; covering and uncovering of wrecks; observe new species; species interactions/behavior; habitat utilization; network of sensors	high - obs system; low - std pkg 3	std pkg 3; multiple cameras/sensors - fiber optic technology	std partners	ID new species; scientific new knowledge
Primary & secondary fish production; understanding geochemical processes					
1 - target on eddies	collect water column, physical data; use satellite imagery; collection of mid/bottom biologics; net and bottom sampling; connecting bio/chem/geo technologies and processes	high	CTD; automated sensors; automated ship - compiling/integrating; management of data; real-time continuous data collection; "conducting satellite cable"; collecting satellite data - SST, SeaWiFS, ARGOS; transmit broadband data		fisheries management; unknown species and processes; impact assessment; education - satellite tracking, real-time video; transmit broadband data
Connectivity of habitats on shelf and edge of shelf; trophodynamic study					
1 - mapping survey	ID connected habitats	high		std partners	MPA location & defining; functionality of MPAs;
2 - targeted; coupling physics and biology	sample; determine source; track history of fish; follow biologics to determine behavior; tagging studies; molecular data analysis	high	spectral technologies; PSATS/conventional tagging; chemical tools		understanding of unknown - ecological systems; behaviors
Submerged cultural resources - document status of wrecks (ships, objects, & settlements); recently uncovered by storms, etc.	ID of sites; site assessment				
1 - systematic survey	submersible onsite; look in historical shipping lanes; sites known in historical records; sub-bottom formation ID	high	std pkg 1 - AUVs; photomosaics; video imagery; multibeam; sidescan sonar; magnetometer; airborne lidar; integrating sensing collection systems and positioning system;	std partners	cultural resource management; education; more effective preservation methods; prioritize sites for recreational, archaeological, historical purposes; designations to national register;
2 - targeted on sites		high	real-time video linked to shore		outreach; adding to record of "mankind in the sea"; paleo sea level changes

technology crosscutting:
couple physical, chemical, biological capabilities in data collection management onboard ship
integrate into continuous logging capability
hull mounted ADCPs that work